# CHINA-PAKISTAN ECONOMIC CORRIDOR IN CONTEXT OF ENERGY CRISIS OF PAKISTAN

## PhD DISSERTATION



*This Dissertation is submitted to National Defence University, Islamabad in partial fulfillment for the degree of PhD in* ***International Relations***

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*Dedicated to*
*My Brother Athar Hussain's Humane and*
*Sincere Efforts, for a Prosperous Pakistan,*
*are Commended and Appreciated!*

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# Abstract

The socio-economic consequences of energy crisis determine the policymaking as it affects the political stability and economic geography of the nation state system in International Relations. Pakistan has been facing the energy shortfall of 5,000-7,000MW in front of 26,000MW demand and 19,000MW supply. In 2015 China-Pakistan Economic Corridor (CPEC) project $62 billion investment fixed 73 percent for energy. This study explains energy dynamics of CPEC keeping in view Douglass North's theory of Institutions found best expressing that Institutions are responsible to establish a structure of incentives that enable economic entrepreneurs to adjust while maximizing their effectiveness. It also assesses the sustainability of CPEC energy component by approaching the literature on 'Sustainable Development Goals' (hereafter SDG's) supported by UNDP. The 7$^{th}$ SDG is to ensure universal access to affordable and clean energy by 2030. The study deliberates the overarching question: Why energy security is central for competition and cooperation in international system; and how national-regional-international economic factors inflate challenges in the process of energy security? The specific objective of the study is to identify and explain the causative factors of energy crisis and its reflection/remedy in the CPEC to assess whether the CPEC energy production will yield the outcomes to eradicate the real causes of the energy crisis. Questionnaires based on Delphi focus research method were served in three rounds to a sample of 16 energy experts having experience over the last15 years. The results of round 1 found energy governance the highest 61%; Climate Change Impact 26% and rising population 13% in ranking of responsible reasons for energy crisis of Pakistan. Round 2 found that the energy crisis 66% were related to decisions and actions committed and 34% were related to decisions and actions omitted by the energy governance. Round 3 found 60% expert view that CPEC energy is not affordable; and 70% expert view that CPEC energy is not clean. The study would be useful to enable government of Pakistan to make 'National Energy Strategy' based on the past experience, and present challenges to innovate the future trends for energy security.

**Key Concepts:** Energy Security; Energy Crisis; Institutional Theory; CPEC; Affordable and Clean Energy

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## List of Abbreviations

| | |
|---|---|
| ADB | Asian Development Bank |
| AEDB | Alternative Energy Development Board |
| APERC | Asia Pacific Energy Research Centre |
| BOI | Board of Investment |
| BOOT | Build Own Operator Transfer |
| BTU | British Thermal Unit |
| CCCC | China Communications Construction Company Ltd |
| CCI | Council of Common Interest |
| CMEC | China Machinery Engineering Corporation |
| COD | Commerical Operation Date |
| CPHGC | China Power Hub Generation Company |
| CPPA | Central Power Purchasing Company |
| CTGC | China Three Gorges Corporation |
| CTF | Trillion Cubic Feet |
| DECL | Dongfang Electric Corporation Limited |
| DISCOs | Distribution Companies |
| ECC | Economic Coordination Committee |
| EIA | Environment Impact Assessment |
| EPA | Enviornment Protection Agency |
| ESI | Energy Security Index |
| GCM | Global Climate Model |
| GDP | Gross Domestic Product |
| GENCOs | Generation Companies |
| GHG | Green House Gases |
| HAVC | HAVC |
| HDI | Human Development Index |
| HUBCO | Hub Power Company Ltd |
| IAEA | International Atomic Energy Agency |
| IDS | Industrial Development Services |
| IMF | International Monetary Fund |
| IPCC | Intergovernmental Panel on Climate Change |

| | |
|---|---|
| IPPs | Independent Power Producers |
| JRC | Joint Research Centre |
| KESCO | Karachi Electricity Supply Company |
| KHPP | Karot Hydropower Project |
| MIT | Massachusetts Institute of Technology |
| MTOE | Million of Tonnes of Oil Equivalent |
| NPP | Nuclear Power Plants |
| NEPRA | National Electric Power Regulagtory Authority |
| NOAA | National Oceanic and Atmospheric Administration |
| NUPG | Nuclear Power Generation |
| NUPP | Nuclear Power Projects |
| OECD | Organization for Economic Cooperation and Development |
| OGRA | Oil and Gas Regulatory Authority |
| PAEC | Pakistan Atomic Energy Comission |
| PCEWG | Pakistan-China Energy Working Group |
| PEPCO | Potomac Electric Power Company |
| PMD | Pakistan Meteorological Department |
| PPIB | Private Power and Infrastrcture Board |
| PV | Photovoltaics |
| RCM | Regional Climate Model |
| SEZ | Special Economic Zones |
| UNEP | United Nations Enviornment Program |
| UNFCCC | UN Framework Convention on Climate Change |
| USAID | United States Agency for International Development |
| WAPDA | Water and Power Development Authority |
| WHO | World Health Organization |
| WMO | World Meterorogical Organization |

# Introduction

'Energy defines the pursuit of state power; international economic relations have dominant tinge for the purpose of energy security'.[1] Economic strategy of the state depends on energy security. Energy security is one of the vital signs of power of states in international relations. The high energy use primarily indicates the high-income levels prevalent among countries. Per person energy consumption in US is 13,250 KW, in China 4,475 KW, in India 806 KW and in Pakistan 471 KW respectively. Pakistan is ranked 114th in energy consumption the world over.[2] Despite the very low energy consumption as compared to other countries Pakistan's energy supply has been found not sufficient to fulfill the demand. The energy price refers business infrastructure and opportunity in a country.[3] Energy tariff in Vietnam 7 cents, in India 7 cents, in China 9 cents, and in Pakistan is 11.5 cents. The facts point out Pakistan's in-competitiveness in international market.

**Energy security and energy crisis are opposite propositions. When there is energy security, there is no energy crisis. When there is energy crisis, there is no energy security.**

The energy shortfall of 5,000-7,000MW in view of 26,000MW demand and 19,000MW supply is evidence of energy crisis of Pakistan till 2015. The energy crisis posed 2.6% GDP loss in 2018 to Pakistan.[4] The energy crisis was realized because of frequent and prolonged energy outages. Mostly the counted reasons of evolved energy crisis in Pakistan are increasing population and its energy consumption patterns, climate change and its impacts on human and natural resources. The causative factors of energy crisis relevant to energy governance are found less counted.

Economic prosperity of a state depends on the performance of its institutions. Energy governance of Pakistan is found inclined to inefficiency; despite the state possesses a lot of energy resources. The potential energy availability according to world energy council,

[1]Musarrat Jabeen, "South Asia and Management of Energy Security", *Regional Studies*, Vol. XXIV, No. 3, (2006)

[2]Pakistan-Electric Power Consumption (kWh per capita), Available At: https://tradingeconomics.com/pakistan/electric-power-consumption-kwh-per-capita-wb-data.html Access On: 25-10-2017

[3]*Times of Islamabad*, (16 October 2018)

[4]"Impact of Electricity Shortage on Economy", *Business Recorder*, (20th September 2018)

Pakistan has 185 billion tons of coal reserves. Pakistan has immense resources of hydropower, estimated to 50,000 MW including both small- and large-scale energy projects.[5] Pakistan holds massive solar potential of 300 days sunshine, in a year that may produce 1900 to 2200 MW of energy.[6] Pakistan has potential of about 346 GW of wind-energy.[7]

The national energy systems are not managed by the state energy governance only; they are affected by foreign investment also. Energy security is linked to the availability of foreign investment in a less development country like Pakistan. Studies have found that Kala Bagh Dam[8] had/has not been constructed in Pakistan because of lack of funds provision from World Bank and other foreign investors. It is also found that the political commitment arises for energy because of availability of foreign investment.

The China Pakistan Economic Corridor (CPEC) project signed in 2015 sponsors energy production by utilizing four energy sources (See Table 0.1). Through CPEC projects, there is likely shift of energy mix from oil-based energy generation to coal based energy generation[9] in Pakistan.

**Table 0.1 CPEC Energy Mix**

| Source | Share in Total |
|---|---|
| Coal | 69% |
| Hydro-Power | 21% |
| Solar | 7% |
| Wind | 3% |

**Source:** China-Pakistan Economic Corridor 2017, http://cpec.gov.pk/

[5]World Energy Council, Available At: https://www.worldenergy.org/data/resources/country/pakistan Access on: 25-10-2017

[6]Musarrat Jabeen, et.al, "Socio-Economic Prospects of Solar Technology Utilization in Abbottabad, Pakistan", *Renewable and Sustainable Energy Reviews*, Vol. 39, (2014), p. 1165

[7]Mazhar H. Baloch, Ghulam S. Kaloi and Zubair A. Memon, "Current Scenario of the Wind Energy in Pakistan Challenges and Future Perspectives: A Case Study", *Energy Report*, Vol. 2, (November 2016)

[8]Daanish Mustafa, Giovanna Gioli, Milan Karnerand Imran Khan, "Contested Water: Subnational Scale Water Conflict in Water", *United States Institute of Peace*, (2017), p. 10

[9]Yasir Arrafat, "Challenges and Solutions in Building CPEC-A Flagship of BRI", *Centre of Excellence, China-Pakistan Economic Corridor*, Working Paper No. 17, (2017), p. 6

## Problem Statement and Research Questions

The trends such as energy outages, high energy prices, unemployment, trade deficit, circular debt, slow economic growth and current account deficit are the indicators of energy crisis. They have affected the economic security of Pakistan. Pakistan faced the energy shortfall of 5,000-7,000MW in view of 26,000MW demand and 19,000MW supply in 2015. Pakistan has resorted to energy production policies particularly associated to foreign investment to fill the energy deficit. China took economic-strategy response to prevalent energy crisis in Pakistan and signed China-Pakistan Economic Corridor (CPEC) project in 2015. (CPEC) a project of $62 billion investment allocated 73% for energy production in Pakistan. Focusing the aforesaid facts, it seems possible to recognize the factors responsible for energy crisis in Pakistan. The research is therefore devoted to present the causes of energy crisis and its relation to energy specifics of CPEC. Also, it is; to assess whether or not the CPEC energy production yielded the results to eradicate the real causes of the energy crisis of Pakistan to enhance energy security of Pakistan. Following are the questions of the study:

1. Why energy security is central for competition and cooperation in international system; and how national-regional-international economic factors inflate challenges in the process of energy security?
2. What are the causative factors of evolved energy crisis of Pakistan?
3. What is the significance of role of informal and formal institutions in the energy crisis of Pakistan?
4. What are the specifics of energy part of CPEC project 2015 and how it has affected the dimensions of energy crisis of Pakistan?

## Hypothesis and Objectives of Research

**Hypothesis**: During the period 2015-18 the relationship between dimensions of energy governance of Pakistan and China-Pakistan Economic Corridor (CPEC) have affected the dimensions of energy crisis of Pakistan.

Following are the Objectives of study:

1. To explore the actual reasons of evolved energy crisis of Pakistan.

2. To identify the energy security calculations those, exist in the energy governance of Pakistan.
3. To describe the specifics of energy part of CPEC project vis-à-vis the reasons of evolved energy crisis of Pakistan.
4. To find out if the Institutional Theory in its premises can explain the dynamics of energy governance and energy crisis of Pakistan.

## Scope of Research

The research is focused on studying the impact of energy crisis on the economic security dynamics of Pakistan. The context is shortfall of 5,000-7,000MW in view of 26,000MW demand and 19,000MW supply during 2015-18. It deliberates trends such as energy outages, high energy prices, unemployment, trade deficit, circular debt, slow economic growth and current account deficit have affected the economic security of Pakistan. Pakistan has resorted to energy production policies particularly dependent on foreign investment. China took economic-strategy lead due to the prevalence of energy crisis in Pakistan and signed China-Pakistan Economic Corridor (CPEC) project in 2015. (CPEC) project of $62 billion investment allocated 73% for energy production in Pakistan. The time period under study is from 2015 to 2018, the year of accomplishment of most of CPEC energy specific projects.

Pakistan is situated on confluence of Middle East, South Asia and Central Asia. Energy Crisis of Pakistan is selected for study in this research as it has distinct dimensions. Pakistan has the 7$^{th}$ largest population and it is front line state to fight global war on terrorism. Energy crisis of Pakistan has brought economic progress to a standstill.

Moreover, Pakistan claims to stand for sustainable development as per the SDG-7 endorsed by UNO for clean and affordable energy. It is vital to build on economic strategy to signify her status in Asia and in the world 'International Economic System’ based on energy security. The study has not only focused the energy crisis of Pakistan, but it has also specifically highlighted the energy crisis in Brazil, China and California.

# Literature Review

**By setting the theme of research it is pertinent to appraise the existing literature on energy crisis, energy governance and CPEC.**

It is reviewed to figure out the gaps bridged in this research. Therefore, this section narrates the pertinent literature about the dynamics of energy security of Pakistan. In view of the primary question the literature review has been organized. That calls to investigate the principal causes of energy crisis of Pakistan founding the energy security calculations and energy policymaking.

## Energy Crisis

Academic interest in the energy security has been found elevated in international politics particularly since the energy crisis of 1973. The reason is growth in energy demand because of dependency of human being on energy revered socio-economic and industrial development. As a result, the energy profile (demand and supply) of countries is counted to refer their quality of life and economic growth. Every state surge to enhance its energy security. The affordable and clean energy is ultimate to economic development and welfare of society endorsed as the7$^{th}$ Sustainable Developmental Goal of UNO.

Crisis is an episode of urgency, threat and uncertainty. It is an event which portrays a vicious and dwindling situation. It is a pivot round which complex options go under stress. Such a situation happens because of sluggish decisions which cause individuals, groups, nations and international community to suffer in the long run.[10] Schabbach and Wesselak defined energy crisis as either a restriction of access to one or more energy sources.[11] Brain and Richard define Energy crisis as an amalgam of increased worldwide energy demands, rising prices, reliance on foreign energy and diminished supplies.[12] Energy crisis have far-

[10]Stephen Benedict Dyson and Paul ‘t Hart, “Crisis Management”, (Oxford: Oxford University Press, 2015), p. 1
[11]Thomas Schabbach and Viktor Wesselak, “Energie”, (Springer International Publishing, 2012)
[12]Brian C. Black and Richard Flarend, “Alternative Energy”, (California: Green Wood, 2010), p. 28

reaching impacts as it triggers energy price hike, conflicts among energy importing and exporting states, and even attacks on related energy infrastructures.[13]

The world faces its fair share of political, economic, social, environmental and other issues but all these problems do not occur in vacuum. They are all connected in one fundamental way through energy and its resources. Consequently, if there is a crisis in energy, our ability to do work and maintain a functioning world is in crisis. This section explains energy crisis in International Relations with a focus on its concept, indicators and causes as well as efforts for energy governance. This is followed by a case study of the energy crisis of the 1970s (specifically 1973 and 1979) to gain a better insight.

In the context of International Relations, the term “energy crisis” is concerned with energy shortages or outbreaks regarding any energy resource involving at least some part of the international system primarily one or more states. This concept is relatively new; it first emerged in the aftermath of the 1970s energy crisis. What exactly constitutes an energy crisis has changed over time; initially the unavailability of energy resources passed as a crisis. Later, the notion of expensive and unaffordable energy was also taken up as a problem. Most recently, with the advent of climate change driven by unhealthy energy consumption, not having access to sustainable energy is also part of the energy crisis. In short, when there is a talk of energy crisis, it means the unavailability of affordable and clean energy resources.

When about to talk of indicators of energy crisis, it refers to those particular criteria which enables to determine whether a crisis is in the making and its extent. According to several sources, indicators of energy crisis include energy outages, number of households/populations without access to energy, share of household income spent on fuels, rate of energy theft, energy consumption per capita, energy intensities industrial, agricultural and transport sectors, overall price hikes in a certain period, energy mixes nationally, regionally and globally, rate of deforestation, ratio of radioactive waste to nuclear energy

[13]Gernot Stoeglehner, Georg Neugebaur, Susanna Erker and Michael Narodoslawsky, “Integrated Spatial and Energy Planning Supporting Climate Protecting and the Energy Turn with Means of Spatial Meaning”, (Springer International Publishing, 2016), p. 28

produced, per capital greenhouse gas emissions, oil discharges into international and territorial waters, air pollutant emissions and net dependency on energy import.[14]

Several factors contribute in causing energy crisis in the world.[15] The first is unequal wealth distribution which allows a certain segment in society to exert control over energy resources. The 99% with only 10% of the world's wealth suffer when prices rise due to energy crises. Secondly, there exists a monopoly of certain actors such as oil producers or technologically advanced countries who forget that collaborated progress is the way to go. As a global community, it also has an addictive dependence on fossil fuels which might be cheap but cause environmental havoc thus leading to a global energy crisis with respect to their "cleanliness".

Global energy politics pave way for crises affecting billion of people. Moreover, unrest in energy producing countries/regions in the forms of war, terrorism and political conflict deters the access and availability of sufficient energy resources to keep the globe running. An example would be that any crisis in Venezuela (the world's largest oil producer) would be dreadful and can become a regional crisis. Lastly, one of the most important causes of an ensuing energy crisis is an increasing global population as more people means more demand of energy, food and water. The world population is increasing at the rate of 1.10% according to 2018 statistics and at this rate, it is anticipated to reach 9.7 billion by 2050 (as opposed to almost 8 billion today).[16] An increasing demand makes equitable distribution of resources even tougher. Poor distribution systems and energy wastages make the situation worse as well.

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[14]"Energy Indicators for Sustainable Development: Guidelines and Methodologies", *International Atomic Energy Agency, United Nations Department Of Economic and Social Affairs, International Energy Agency, Eurostat and European Environment Agency*, (Austria: IAEA, 2005), pp. 11-15

[15]Eugene D. Coyle and Richard A. Simmons, *Understanding the Global Energy Crisis* (Indiana: Purdue University Press, 2014), pp.11-26

[16]Growing at a Slower Pace, World Population is expected to Reach 9.7 Billion in 2050 and Could Peak at Nearly 11 Billion Around 2100, *United Nations Department of Economic and Social Affairs*, (17 June 2019), Available At: https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html. Access On: 25-10-2017

The economic crisis of 1970 incited unimaginable level of stagnation and inflation during that era which even further led to the inception of the term Stagflation.[17] Western economics was the primary target of this infamous recession, but as all odds, some countries also boomed during this recession such as Canada, Mexico along with oil rich countries of Latin America; such as Venezuela. The shortage of oil in market during the year of 1973 occurred principally because of Arab defeat in Yom Kippur war, when United States supported Israel against the OPEC states.[18] Thus these less developed, but oil rich countries of Middle East led by King Faisal of Kingdom of Saudi Arabia exploited the urgent need for oil of the developed industrialized countries who significantly lacked available alternative resources. These temporary years of energy crisis were taken up and analyzed by western countries and particularly United States as a threat to their national security; hence the term "Energy Security" also started to make rounds in market during that period. The geopolitical location of oil resource in abundance in Middle East was also a matter of eminent concern for the troubling lands of ME were slowly slipping towards crisis scenario with every New Year and skirmishes were being expected later as well. Moreover, Technology industry of west was extremely and entirely oil dependent by that time therefore, the availability of oil for the sake of survival of economic prosperity was a matter of deep importance.

The prices of crude oil skyrocketed from $3/barrel before 1973 to $12/barrel in 1974,[19] petrol prices reached new highest levels and Europe started rationing by using the old coupons left of World War II. Inflation and grave losses of labor at industrial sector made the USA and European countries invest in other form of energy such as solar Energy. Despite that, organization like Economic Roundtable was created in 1972, for the sake of catering the crisis like those of 1973, yet the situation was inevitable and equally unimaginable when it came to taming it smoothly.

The second oil crisis was also linked to the developments in the Middle East. The Iranian Revolution began in 1978 and ended with collapse of the Pehlavi dynasty and the rise

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[17]Mankiw, N. Gregory and Scarth William M, *Macroeconomics: Canadian Edition Updated*. (New York: Worth Publishers, 2009), p. 270.
[18]Terry MaCalister, "Background: What Caused the 1970s Oil Price Shock?", *The Guardian*, (3 March 2011)
[19]Kimberly Amadeo, "OPEC Oil Embargo, Its Causes, and the Effects of the Crisis", *The Balance*, ( 30 March 2019)

of Ayatollah Khomeini to power in the new Islamic Republic. Oil supply disruption was not the basic reason of crisis rather the hoarding that began by the fear of prompted further disruption. The oil prices elevated precariously in mid-1979, which eventually amplified even further by the end of 1980. Moreover, oil production in Iran decreased by 4.8 million barrels/day in January 1979. The increase in cost resulted in a crisis that was the result of a growing global economy and precautionary demand for oil.[20]

The fiscal policy decisions by US were the prime generator of economic cum energy crisis, the gasoline price rose exponentially due to their restriction. Higher gasoline prize contributed in higher prices of products and services. The controls allowed the prices of gasoline to be raised each month compared to the previous, which automatically interested people in hoarding it and selling it when the prizes are high. Large refiners were ordered to sell oil to small refiners by the Department of Energy but the smaller refineries were less complexed and produced lesser gasoline compared to their counterparts deepening the shortage. This situation was major reason of President Jimmy Carter's support going downhill. It highlighted the inefficiencies in government policies in handling the fuel markets. Precisely why, President Reagan abolished control of the federal government over domestic products and crude oil dispensation right after his inauguration.

Because of such crisis at hand, the industrialist proposed to reduce dependence on non-OPEC countries, meanwhile electrical utilities and energy providers switched from oil to nuclear energy, coal or natural gas.[21] Multiple government sponsored programs and researches were initiated to find a suitable alternative of oil energy. Meanwhile, several oil exploration projects were installed in non-OPEC countries like Siberia, North Sea, Alaska and Gulf of Mexico.[22] The efforts collectively decreased oil demand up to 5 million barrels,

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[20]Alejandero Reus, "What can the Crisis of U.S. Capitalism in the 1970s Teach us about the Current Crisis and its possible outcomes?, Dollar and Sense, 2009 Archive", Available At: http://www.dollarsandsense.org/archives/2009/1109reuss.html Access on 9 November 9, 2019,

[21]Ference L. Toth and Hans Holger Rongner, "Oil and Nuclear Power: Past, Present and Future", *Energy Economics*, Vol. 28, No. 1, (January 2006)

[22]Simon Bomerley, *American Power and Prospect for International Order* (Cambridge: Polity Press, 2015), p. 95

worldwide by the end of year 1986. Subsequently, demand for OPEC market dropped from 50% in 1979 to mere 29% in 1985, due to such efforts in line.[23]

## Energy Governance

Since the crisis of the 1970s which shook the world especially the Western part of it, efforts started to govern energy at a global level. Global governance is defined aptly as "any activity with the aim to sway someone and occurs in the area taken up by states or in a space such that it influences the states".[24] It is not an overarching authority over the states; it has been established with the consent of governments to resolve issues that transcend national boundaries therefore paving way for a need of collaborative action.

Global Energy Governance (GEG), the roots of which can be traced to the beginning of the twenty-first century, was prompted by geopolitical developments, increasing environmental deterioration and volatility in the fossil fuel market.[25] It can be categorized into two types. The first is in the form of international and regional organizations and regimes which work hard to prevent such crises from happening again. The United Nations has expanded its agenda to include energy governance. One of its Sustainable Development Goals passed in 2015 is "Clean and Affordable Energy"[26] and it is synergized with other SDGs to provide modern energy services to all people by 2030. The International Energy Agency found in 1974 and based in Paris is the "closest thing we have to a World Energy Organization"[27] and certainly important when it comes to GEG. Other multilateral institutions for energy governance include Organization of Petroleum Exporting Countries (OPEC, established 1960), United Nations Industrial Development Organization (UNIDO, established 1966) and the Energy Governance Union within the EU (which was passed in 2015 and is still in a formative phase). Countries also formulate bilateral energy agreements to meet their requirements. An example is the Nord Stream gas pipeline whereby Russia provides gas to

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[23]Sadek Boussena, "OPEC's Learning Process", *Energy Studies Review*, Vol. 6, No. 1, (1994), , pp. 61-72

[24]Lawrence S. Finkelstein, "What is Global Governance?", *Global Governance*, Vol. 1 No. 3 (1995), pp. 367-372

[25]Thijs Van de Graaf and Jeff Colgan, "Global Energy Governance: A Review and Research Agenda", *Palgrave Communications* 2, (2016)

[26]"Goal 7: Affordable and Clean Energy", United Nations Development Programme, Available At: https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-7-affordable-and-clean-energy.html. Accessed on 9 November 2019

[27]Thijs Van de Graaf T, "Fragmentation in Global Energy Governance: Explaining the Creation of IRENA", *Global Environmental Politics,* Vol. 13, No. 3 (2015), pp. 14–33

Germany thus wonderfully exhibiting how differences are set apart when it comes to global energy governance. However, considering the crucial nature of this issue, the world is still not doing enough.

The second category of GEG is informal governance that takes place through the actions of non-governmental actors such as NGOs, think-tanks, universities, civil society, professional groups, interest groups, lobbies, multi-national companies and the like. These entities work to conduct research, make plans, coordinate with government bodies and represent different interests that need to be secured within the realm of energy governance.

A reasonable literature exists regarding the energy crisis of Pakistan offered by national and international authors and organizations. The literature mostly highlights the dimensions of energy crisis such as energy outages, high energy prices, unemployment, trade deficit, circular debt, slow economic growth and current account deficit affecting the economic security of Pakistan. The direction set for literature review in this study is specific to principal reasons of energy crisis. The section composes literature associated with different aspects of energy crisis of Pakistan. Due to climatic change and its manifestations world has seen an increase in temperature since 19th century.[28] There is a positive relationship between increase in temperature and rising energy demands.[29] Population of Pakistan is 207 million[30] which is a source of increase in energy demand. Population growth rate in Pakistan is 2.4% which is double of other regional states like Sri Lanka, India and Bangladesh.[31] The principal enquiry of the study is about the evolution of energy crisis of Pakistan, so the literature reviewed is about energy security calculations and energy governance[32] in the context of energy crisis.

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[28]"Basic Guide to Climate Change", *Lead Pakistan: Inspiring Leadership for a Sustainable World*, Available At: http://www.lead.org.pk/cc/basicguide_climate_change.html Access on 25-10-2017

[29]Rafat Mahmood, Sundas Saleemi and Sajid Amin, "Impact of Climate Change on Electricity Demand, A Case Study of Pakistan", *PIDE,* (16 Dec 2013)

[30]Fahim Zaman, "Census 2017: How Can Flawed Results Have any Credibility", *Dawn,* (21September 2017)

[31]"Alarming Population Growth Rate", *Pakistan Today,* (13 May 2018)

[32]In this Study the Notion of 'Energy governance," Taken to Mean National Collective Action and Efforts (The Formal and Informal Narratives and Actions) Undertaken to Manage and Distribute Energy Resources and Provide Energy Services, Offers a Meaningful and Useful Framework for Assessing Energy-Related Challenges to Pakistan.

Muhammad Asif in his book, “Energy Crisis of Pakistan: Origins, Challenges and Sustainable Solutions”, (2012) seeks to understand that despite various energy policies, nation has been facing energy scarcity since a few decades. In the book the writer says that energy crisis is causing economic loss of more than $100B per annum.[33] The book primarily aims to educate various stakeholders of society on the subject of energy in a wider context of the energy crisis of Pakistan. In this backdrop, the writer examines the role of the policy and decision-making circles, energy departments, industry, and academia. Having discussed the structure and implications of the crisis, it presents policy guidelines and provides a set of robust solutions to achieve energy prosperity in the country.

From 2000 to 2008 increase in the consumption of commercial energy was 8.4% per annum in Pakistan. Highest rate of increase in the consumption of energy, 12.5%, was recorded in industrial sector.[34] The period proved highest to energy crisis of Pakistan. According to World Bank, insufficient energy caused $5.8B economic loss or 2.6% GDP loss in Pakistan.[35] Crisis management is to cope with crisis. It initiates with decision-making. It requires an ability to summon all the capabilities, based on crisis type, which may ensure the management of the crisis.[36] Energy crisis management is a multi-valued concept. It requires multi-level changes in society for the process of energy crisis management.[37]

Energy crisis management is linked to the performance of state institutions and energy policies of the state. Energy policies focus on making available sufficient energy sources to meet the needs of society. To have wisdom of energy crisis management; it is pertinent to glance at the other states in international system who successfully managed the energy crises in the 21th century. The study highlights the examples of California, China and Brazil. California’s Energy Crisis 2000: California experienced energy price hike in 2000, the prices

[33]Muhammad Asif, *Energy Crisis in Pakistan Origins, Challenges and Sustainable Solutions*, (Oxford University Press, 2012)
[34]Rashid Azia and Munawar Baseer Ahmad, “Pakistan’s Power Crisis: The Way Forward”, *United States Institute of Peace*, (2015), p. 6
[35]Hussain Samad and Fan Zhang, “Electrification and House Hold Welfare: Evidence from Pakistan”, Policy Research Working Paper, No. 8582, *World Bank Group*, (September 2018), p. 3
[36]Robert L., and Pfaltzgraff, “Crisis Management: Looking Back and Looking Ahead”, *Hellenic Ministry of National Defence*, (2 July 2008)
[37]Mirjana Golusin, Sinisa Dodic and Stevan Popov, “Sustainable Energy Crisis Management” (Waltham: Elsevier Inc: 2015), p. 363

went from 3 cents to 9 cents.[38] The Federal Energy Regulatory Commission (FECR) on 25 April 2001, declared a plan for energy market stability, price relief and efficient management. In less than twenty days, it announced regulatory measures for a reliable increase in energy supplies.[39] California Independent System Operator (CAISO) another institution took the responsibility of demand and supply coordination which was previously owned by private utilities. With the help of various institutions rules were introduced regarding regulating energy sectors. The price came down to 6 cents. In November 2003, Governor Davis ended the state of emergency that proved energy crisis management.

In 2004 China's energy crisis surfaced due to shortage of 30,000MW and 6.21% energy losses hit 26, out of 34, provinces of China. Government introduced various reforms and encouraged further private investment in energy. Local governments were allowed to increase investment in energy sector, without the approval of central government. Central government started restructuring of state-owned energy plants to compete the markets. The crisis was resolved by addition of 237,500MW into national grid.[40]

Brazil Energy Crisis 2001: Brazil was hit by energy crisis in consequence to climate change impact; the drought de-capacitated Brazil's hydel energy production. Government delayed the construction of energy plants and couldn't forecast future needs of energy.[41] As a result, gap between demand and supply increased, coupled with rising per unit energy prices. The Federal Government introduced the institution of Rationing Programs, and established 'Energy Crisis Management Chamber.' The distributers and large consumers were obliged into long-term energy purchase contracts. Large scale investment was introduced in hydropower by building small dams. Government became successful in managing energy crisis by focusing on alternative energy generation sources.

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[38]James L. Sweeney, "The California Electricity Crisis: Lessons for the Future", *Hoover Institution Press*, (Summer 2002), p. 6

[39]Subsequent Events-California's Energy Crises, Available At: https://www.eia.gov/electricity/policies/legislation/california/subsequentevents.html Access on: 29-10-17

[40]Yu Shunkun, Zhou Lisha and Li Chen, Op.cit.,

[41]David Watts and Rafael Ariztia, "The Electricity Crisis of California, Brazil and Chile: Lesson to the Chilean Market", Paper presented at Large Engineering Systems Conference on Power Engineering, Halifax, Nova Scotia, Canada, (26-28 June 2012), p.4

In a state, institutions are designed to define preferences and powers. Institutions deliver common meanings and cognitive structures which define behaviors. They are established to shape preferences and set basis for human choice.[42] North states, “Institutions are the rules of the game in a society or more formally are the humanly devised constrains that shape human interaction.” The institutions help the structuring of human interaction. Formal institutions are devised with formal rules and their binding force. They consist of constitutions, laws and legal procedures. They have special feature of being specific and precise. In everyday behavior and actions, formal rules occupy specific portion while norms occupy vital place. So, institutions have formal rules and informal norms with their enforcement dimensions.

Douglas C. North in his book, “Institutions, Institutional Change and Economic Performance”, discusses that in a society institution cater economic and political framework that promote decision making and successful economic changes. The major aim of the institution is to reduce uncertainty by developing a stable and efficient structure for economic interaction. Institutions are evolved through different conventions, legal procedures, contracts between individuals, norms of the statue and common laws. Institutions, with a defined structure of economy, increase feasibility and profitability during economic activity.[43] North argues that institutions are established to control the obstacles defined as transaction costs and institutions structure the transaction costs of exchange. Institutions influence the cost of transaction which includes the cost of designing, negotiating and enforcement of business contract. When laws are poorly defined and enforced, the value of risk will be high and prospects of economic growth will be reduced. North’s model of institutional framework focuses that the uncertainty in human exchange is always elevated by forging competent institutions. Problems emerging from imperfect and asymmetric information can be reduced by developing institutions. In this connection, the book published in 1994, is useful to cover theoretical dimension of the dissertation.

Dr. Abdul Latif in his book “The Implementation of Energy Policy in Pakistan (2017)”, discusses that the background of energy planning in Pakistan can be understood well

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[42]Daniel Friel, “Understanding Institutions: Different Paradigms, Different Conclusions”, *Revista De Asministracao*, Vol. 52, (2017). p. 212

[43]Douglas C. North, *Institutions, Institutional Change and Economic Performance*, (New York: Cambridge University Press, 1990)

in the light of various five years plans (from 1947 to sixth five-year plan 1983-88). The writer says that before the presentation of first national energy policy in 1994, energy issue had been addressed in these development plans. The first development plan in Pakistan was prepared in 1955 and the then government allocated PKR 1100 million to the energy sector, which was 8.7 percent of total development plan for the country. In 1960's Pakistan decided to build large dams to generate hydropower. Tarbela and Mangla dam were planned and executed with generation capacity of 2100MW and 1000MW respectively. According to the writer coal utilization found ignored during 1972-78; however, it gained recognition in fifth five-year plan. In 1980 government established National Energy Policy Committee (NEPC) with an objective to constantly review the energy policy. The writer said that in late 1980's attention was given to renewable energy resources and it was decided to conduct research and development activities for renewable energy sources.[44]

M. Mujahid Rafique and S. Rehman, in their paper on "National Energy Scenario of Pakistan-Current Status, Future Alternatives and Institutional Infrastructure: An Overview (2017)", argue that energy sector is being controlled by an enormous number of energy producing companies. They have their own interests and so their own paths of processes and operational functions. This complex institutional framework has rendered Pakistan's energy scenario into an unmanageable and complicated setup.[45] The analysis of the article shows that administration of the state proved incapable to explore alternative resources for energy production and long-term energy plans. Increased energy demand by industry, agriculture and rapidly growing population has widened the gap between demand and supply. Bunch of issues has contributing to energy crisis. Inappropriate policies have intensified the crisis.

Pakistan announced its first energy policy in 1994. This study assesses the efficacy and impact of energy policies by highlighting the policy experiences causing energy crisis in Pakistan. It is found that the energy policies were developed with less focus on clean and affordable energy.

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[44]Abdul Latif, "The Implementation of Energy Policy in Pakistan", (Karachi: Royal Book Company, 2004), p. 10

[45]M. Mujahid Rafique and S. Rehman, "National Energy Scenario of Pakistan-Current Status, Future Alternatives and Institutional Infrastructure: An Overview", *Renewable and Sustainable Energy Reviews*, Vol. 69, (2017), p. 21

This research identifies two perspectives of energy governance and energy crisis of Pakistan: The Commissions in Energy Policy making of Pakistan e-g, Independent Power Producers (IPPs), and Omissions in Energy Policymaking for example in the last 45 years no policy was made to construct the bigger dams like Tarbela[46] and Mangla.[47] The role of each of perspective is significant bridge the gap between energy demand and supply in Pakistan.

This study links energy crisis to the state of energy governance of Pakistan. Energy governance is a process of decision making and implementing them with efficiency and accountability. Pakistan suffers from institutional and structural disconnections and mismanagement in prioritizing energy security[48] by the politicians. The dynamics of energy governance of Pakistan are deliberated in chapter 4; here features of energy governance are presented.

In Pakistan Ministry of Water and Power leads Energy Governance to produce and distribute energy. The authority makes policies, generates energy and controls the chain of its distribution (See Figure 0.1). National Electricity and Power Regulation Authority (NEPRA) is a rule-making authority.[49] Energy governance of Pakistan is integrated into three institutions. Major producers are Water and Power Development Authority (WAPDA), Karachi Electricity Supply Company (KESC) and Pakistan Atomic Energy Commission (PAEC). WAPDA provides energy to all Pakistan except Karachi. Energy distribution to main city of Karachi and its surrounding is the responsibility of KESC. WAPDA manages hydropower and water resources of the country. PEPCO is responsible for generation, distribution and billing of energy. It also manages the affairs of fourteen energy-sector companies. These fourteen companies comprise of four energy producers (GENCO) and nine distributers (DISCO) and the 'National Transmission and Dispatch Company (NTDC). Since 1994, twenty-seven IPPs on national level are contributing in energy production.

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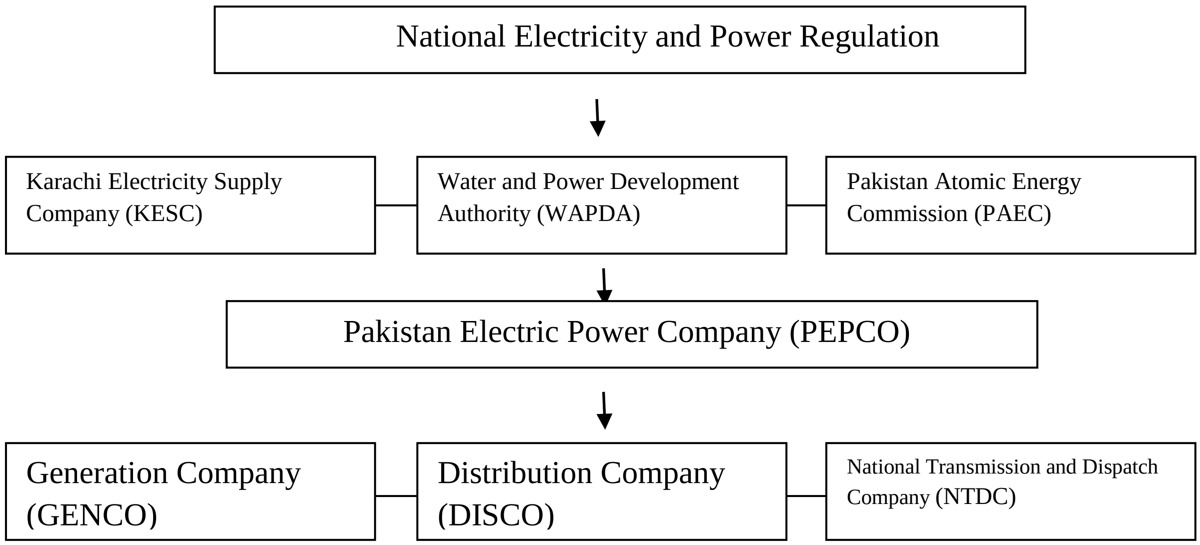
[46]Terbela Dam: In 1976, construction of Tarbela Dam was completed as a component of Indus Basin Projects. Total cost of the project was $1.497 Billion. The project was funded by World Bank and International Development Association (IDA).

[47]Mangla Dam: In 1967, construction of Mangla Dam was completed. Total cost of the project was $1.473 Billion and was financed by World Bank and Asian Development Bank

[48]Pakistan, Friends of Democratic. Integrated Energy Sector Report and Plan, *FODP*, 2010

[49]"Pakistan's Economic Survey 2015-14", *Finance Division*, (Government of Pakistan), p. 218

**Figure 0.1 Formal Institutions and Energy Governance in Pakistan**




Source: Self Extract

PEPCO produces thermal based energy and it also buys energy from various producers like PAEC and IPP units.[50] In the breakdown structure of energy production, WAPDA is responsible for hydel energy, PAEC for nuclear energy, KESC for Thermal, GENCOs for thermal energy and IPPs Hydel and Thermal.[51] Transmission and Distribution (T&D) is found inefficient, under-developed.[52]

Foreign investment is about investing for profit in resources available in other countries. Foreign investment signifies the economic geography of a state and helps to determine its foreign influence. It promotes the profile of investing state while enhances the regional and international state of the host country as well. Energy security is linked to the availability of foreign investment in a less development country like Pakistan. To attract foreign investment state institutions, consume certain information. Problems emerging from

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[50]Mubashir Qasim and Koji Kotani, "An Empirical Analysis of Energy Shortage in Pakistan", *Asia-Pacific Development Journal*, Vol. 21, No. 1, (June 2014), p. 146

[51]Shakeel Khan and Hafiz Farhan Ashraf, "Analysis of Pakistan's Electric Power Sector", *Blekinge Institute of Technology*, (2015), p. 5

[52]M. Mujahid Rafique and S. Rehman, "National Energy Scenario of Pakistan-Current Status, Future Alternatives and Institutional Infrastructure: An Overview", *Renewable and Sustainable Energy Reviews*, Vol. 69, (2017), p. 157

imperfect and asymmetric information can be reduced by developing institutions. Institutions cater economic and political frame work that promotes decision making and successful economic changes. There seems a shortage of academic literature discussing the pivot of institutions to forge energy security through foreign investment particularly in Pakistan. In this regard, some of the available literature is discussed.

## China-Pakistan Economic Corridor Project 2015

CPEC 2015 project is a $62 billion investment which is divided into two domains; energy and communication. For energy, $34.746 billion have been reserved which amounts to 73% of total investment.[53] The magnitude of CPEC energy investment is extraordinary. The current price tag of CPEC is six times than total developmental assistance ($7.5b) of United States to Pakistan from 2009 to 2014.[54] Energy domain of CPEC is further divided into two parts: generation of energy and its transmission. CPEC is meant to boost energy-generation capacity of Pakistan. In short term phase 2020, it is expected that 15 out of 21 projects will start functioning, giving sufficient input to national grid to overcome scarcity of energy.[55] (See Table 0.2)

Muhammad Ishaq, Ruan Jian Ping and Bilal Ahmed, in their research paper on 'China-Pakistan Economic Corridor (CPEC): Opportunities, Threats and challenges (2017) argue that energy is the necessity of modern mechanic age and energy crisis challenges the working of a state. Pakistan is facing energy crisis. Political authorities are aware of their responsibility but not sincere in alleviating this issue. The writers examine that China Pakistan Economic Corridor is an energy drawn infrastructural project with the investment of worth $62 billion. This amount will be distributed into various sectors in such a way that energy sector will get $34 billion, $11.8 billion are allocated for infrastructural development, and $622 million for the development of Gwadar port.[56]

[53]Mehmood Hussain and Sumara Mehmood, "Chinese Soft Power Approaches Towards Pakistan: An Analysis of Socio, Economic and Political Impacts", *Malaysian Journal of International Relations*, Vol. 6, (2018), p. 55

[54]Michael Kugelman, "The China-Pakistan Economic Corridor: What It Is, How It Is Perceived and Implications for Energy Geopolitics," in "Asia's Energy Security and China's Belt and Road Initiative", op.cit., p. 17

[55]The Economic Benefits of Modern Silk Road: The China-Pakistan Economic Corridor (CPEC)", *Pak-China Institute*, p.13

[56]Muhammad Ishaq, Ruan Jian Ping and Bilal Ahmed, "Pakistan-China Economic Corridor (CPEC): Opportunities, Threats and Challenges", *International Affairs and Global Strategy,* Vol. 52, (2017)

**Table 0.2: Completed CPEC Projects and Output**

| Sr. No | Project Name | Capacity (MW) |
|---|---|---|
| **1** | Sahiwal Coal Power Plant (Super Critical) | 1320 |
| **2** | Port Qasim Coal Power Plant (Super Critical) | 1320 |
| **3** | HUBCO Coal Power Plant (Super Critical) | 1320 |
| **4** | Engro Thar Coal Power Plant (Sub Critical) | 660 |
| **5** | Quaid-e-Azam Solar Park | 400 Completed 600 Under construction |
| **6** | Hydro-China Dawood Wind Farm | 50 |
| **7** | UEP Wind Farm | 100 |
| **8** | Sachal Wind Farm | 50 |
| **9** | Three Gorges Second and Third Wind Power Project | 100 |
| **Total Capacity** | | **5320** |

**Source:** China Pakistan Economic Corridor, Available At: http://cpec.gov.pk/ Access On 23-09-2018

Javaid Akhtar, Muhammad Imran Yaqub, Javed Iqbal, Naseer Sheikh and Tanzila Saba in their article "Way Forward in Meeting Energy Challenges in Pakistan", (2017) argue that in energy sector of Pakistan, energy projects of CPEC has attracted massive investments.[57] Energy investment of CPEC has not only boosted the confidence of the government but it has also encouraged private sector investments. The authors further said that if energy projects of CPEC get completed in proposed time, energy crisis of the country would decrease to a significant level. In their opinion, in future, 8% surplus demand of energy is expected. So, it is necessary for the government to ensure the completion of these projects in prescribed time.

Michael Kugelman in "Asia's Energy Security and China's Belt and Road Initiative" a research report published by The National Bureau of Asian Research in 2017 reported that in total CPEC investment, major portion is fixed for energy. The magnitude of CPEC energy

[57]Javaid Akhtar, et.al., "Way Forward in Meeting Energy Challenges in Pakistan", *International Journal of Ambient Energy*, (2017), p. 112

investment is extraordinary. The current price tag of CPEC ($62b) is six times more than the United States total developmental assistance ($7.5b) to Pakistan from 2009 to 2014.[58] The writer reports the purpose to boost energy production capacity of Pakistan. In CPEC energy projects, coal, hydel, solar and wind are the sources of energy production. Coal is the 69% source of CPEC energy projects.

Shebonti Ray Dadwal and Chithra Purushothaman, in their article "CPEC in Pakistan's Quest for Energy Security (2017)", discuss that in modern world, states compete through geo-economic means, instead of geopolitical means. CPEC is evidence of such relationship. In 2015 China initiated Belt and Road Initiative (BRI) to strengthening its relations with Asia, Europe and Africa. BRI is an investment of about $4-8 trillion and would cover two-third land mass of the world, across 65 countries with 4.4 billion population.

## Identified Gap in Literature

The reviewed literature helped to identify that energy governance is the significant reason of energy crisis of Pakistan has not been focused and discussed. Research for this reason needed in view of the fact that the energy crisis invaded and invades into socio-economic, politico-economic and geo-economic status of Pakistan.

Previous investigations about China's investment have mostly focused the magnitude of CPEC expense (73%) on energy in Pakistan as remedy to energy crisis faced by Pakistan. The significance of this study is to find out the response in CPEC to dimensions of energy security; energy production dependency, energy supply certainty, energy affordability, and energy sustainability. The study encompasses efficiency of energy governance. It also highlights that how the governments deemed CPEC and initiated to sign it. The executive idea is based on the relationship between the major reasons of energy crisis and the CPEC; assumed a viable solution to energy crisis of Pakistan.

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[58]Michael Kugelman, "The China-Pakistan Economic Corridor: What It Is, How It Is Perceived and Implications for Energy Geopolitics," in "Asia's Energy Security and China's Belt and Road Initiative*", The National Bureau of Asian Research*, (2017)

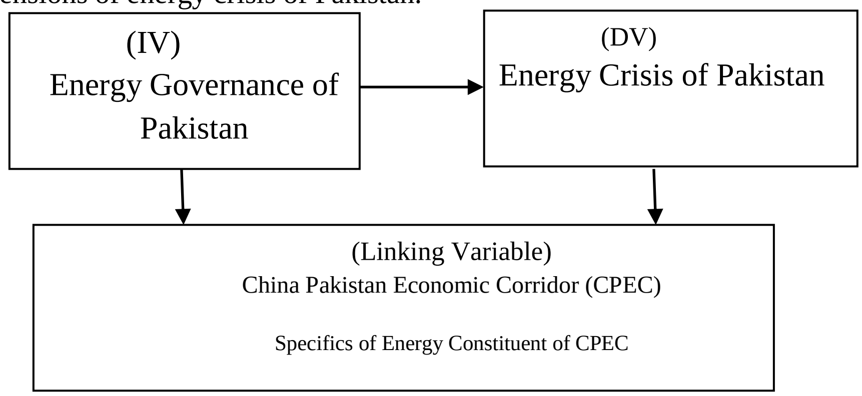
Review of the existing literature lighted that energy crisis of Pakistan are not realized in perspective of energy governance and energy projects. Research in this direction is required since Pakistan has been found dependent on foreign investment for energy development and energy security. Mangla dam was constructed in 1967, and Tarbela dam in 1976 respectively based on foreign funding. Since 1976 no other large project of energy production came into being in Pakistan. The intra state variables of energy governance alone cannot help to identify the reasons of energy crisis in Pakistan unless it is complimented by identification and description of foreign investment referred to diverse interests in the state.

The review has discovered that the focus of literature has been either limited to indicators of energy crisis or impact of energy crisis but lacks to focus the real factors responsible for energy crisis. The search for underlying patterns of decisions and actions of energy governance causing energy crisis in Pakistan is unexplored. The dissertation, therefore, argues that the energy crisis of Pakistan has been caused due to lack of foreign investment or inefficient management of foreign investment for energy development. It furthers the concept of economic strategy based on energy security.

## Variables and their Explanation

The research revolves around two variables: Energy governance is independent variable that refers to institutional and correlated dynamics of energy crisis. The variable is chosen on the bases of Delphi round 1 result. 61% experts chose energy governance as the leading independent variable causing energy crisis in Pakistan; compared to global climate change impact and population pressure raising the energy demand. Energy crisis is dependent variable. Energy part of (CPEC) is presented as a linking variable affecting the dimensions of energy crisis of Pakistan (See Fig 0.2)

**Figure 0.2 Argument of the Study:** "During the period 2015-18 the relationship between dimensions of energy governance of Pakistan and China-Pakistan Economic Corridor (CPEC) have affected the dimensions of energy crisis of Pakistan."




## Methodology

Here the study describes the conceptual position, theoretical framework and research method to collect data for analysis and interpretation. The conceptual position is identified as 'Energy Security and Energy Crisis of Pakistan'. This dissertation applies Energy Security Index (ESI) comprising of four indicators (See Table 0. 3) to assess the status of energy security of Pakistan predicting the energy crisis of Pakistan.

**Table. 0.3 Energy Security Index**

The ESI measures the energy status of states in four dimensions:

1. Energy Production Dependency: Know how, as measured by availability (one third weight) and utilization (one third weight) of energy resources as per set of politics (one third weight).
2. Energy Supply Certainty: A certain supply of energy, as measured by costs incurred to insure the security of energy supply.
3. Energy Affordability: Affordability as measured by per capita energy consumption at purchasing power parity (PPP) in USD.
4. Energy Sustainability: Environmental safety as measured by environmental impact assessment.

**Source**: Musarrat Jabeen, "South Asia and Management of Energy Security", *Regional Studies,* Vol. XXIV, No.3, (2006)

## Theoretical Framework

Douglas C. North in his book, “Institutions, Institutional Change and Economic Performance”, discusses that in a society institution cater economic and political framework that promote decision making and successful economic changes. The major aim of the institution is to reduce uncertainty by developing a stable and efficient structure for economic interaction. Institutions are evolved through different conventions, legal procedures, contracts between individuals, norms of the statue and common laws. Institutions, with a defined structure of economy, increase feasibility and profitability during economic activity.[59] North argues that institutions are established to control the obstacles defined as transaction costs and institutions structure the transaction costs of exchange. Institutions influence the cost of transaction which includes the cost of designing, negotiating and enforcement of business contract. When laws are poorly defined and enforced, the value of risk will be high and prospects of economic growth will be reduced. North’s model of institutional framework focuses that the uncertainty in human exchange is always elevated by forging competent institutions. Problems emerging from imperfect and asymmetric information can be reduced by developing institutions. In this connection, the book published in 1994, is useful to cover theoretical dimension of the dissertation.

According to the theory of institutions offered by Douglas North the institutions have two dimensions the informal and formal referred Pakistan. The theory is adopted as per table 0.4. Economic institutional structure[60] is important because it serves as a pre-condition for efficient economic performance.[61]

The theory has two levels of analysis as follows:

- ☐ Informal institutions involve social norms, customs and behavioral rules
- ☐ Formal institutions include law, organizations and economic agents.

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[59]Douglas C. North, *Institutions, Institutional Change and Economic Performance*, (New York: Cambridge University Press, 1990)

[60]The Institutional Structure is Comprised of more than one Institutions.

[61]Pasquale Tridico, “Institutional Change and Economic Performance in Transition Economics: The Case of Poland”, *Sussex European Institute*, (2004), p. 4

**Table 0.4 Dimensions of Institutions vis-à-vis Energy Governance referred Pakistan**

| | Dimensions of Institutions | Dimensions of Energy Governance of Pakistan |
|---|---|---|
| 1. | Informal Institutions: Set of rules socially shared and communicated | Manifestoes and policies of political parties in Pakistan |
| 2. | Formal Institutions: Set of rules regarding the repetition of activities, constancy and the order of predictability | NEPRA, WAPDA, KESC, PCAE |

Source: Self Extract

**Common surveys try to identify what it is? Whereas the Delphi method attempts to address what could/should be.**

This study relies on 'Delphi Focused Analysis' method to organize expert knowledge. Human behavior persists diversely to respond different challenges as per their societal and knowledge dispositions in contact to energy crisis. The scheme of this study tries to assess the link between energy governance and energy crisis of Pakistan referred CPEC. Delphi focused activity was held in February, 2018-2019.

The Delphi method developed at the Rand Corporation in the 1950's is widely used and accepted method for achieving convergence of opinion concerning real-world knowledge solicited from experts within certain topic areas. Predicated on the rationale that, "two heads are better than one". [62] The Delphi method is designed as a group communication process that aims at conducting detailed examinations and discussions of a specific issue for the purpose of goal setting, policy investigation, or predicting the occurrence of future events.[63] Common

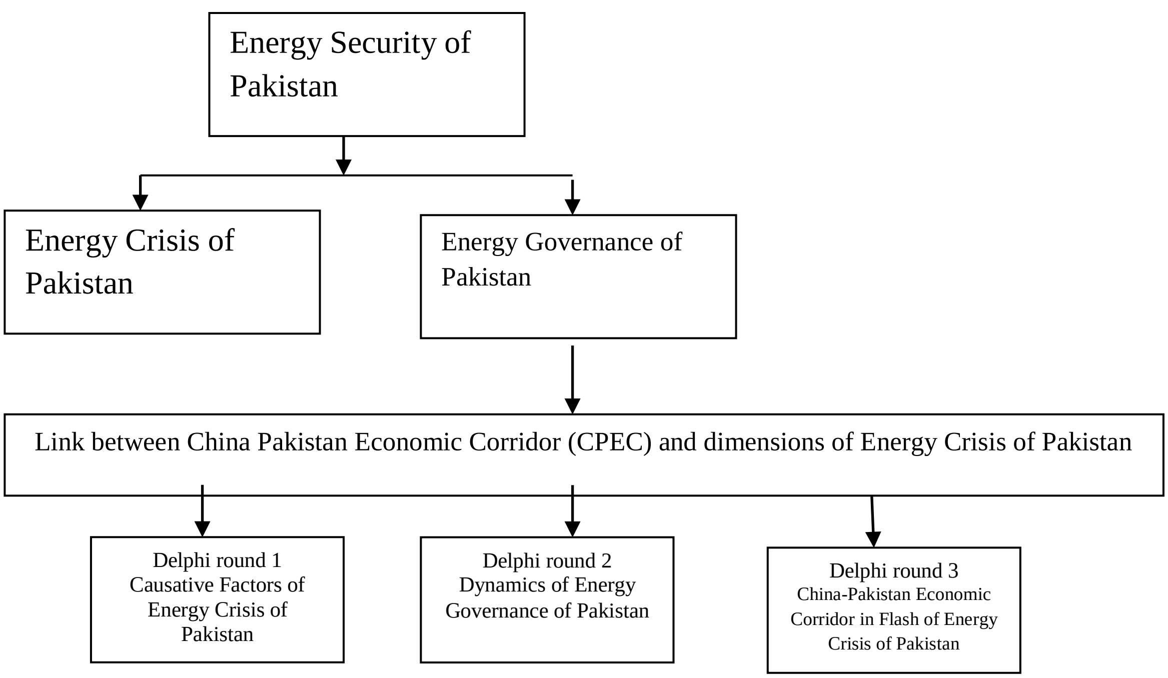
[62]Dalkey, N. & Helmer, O. (1963). An Experimental Application of the Delphi Method to the Use of Experts. *Management Science,* Vol. 9 (3), p. 458

[63]Ulschak, F. L., "Human Resource Development: The Theory and Practice of Need Assessment, Reston, VA: Reston Publishing Company, Inc., (1983), Turoff, M., & Hiltz, S. R., "Computer based Delphi process", In M. Adler, & E. Ziglio (Eds.), "Gazing into the Oracle: The Delphi Method and its Application to Social Policy and Public Health London, UK: Jessica Kingsley Publishers, (1996), pp. 56-88, Ludwig, B. G. Internationalizing Extension: An Exploration of the Characteristics Evident in a State University Extension System that Achieves Internationalization, Unpublished Doctoral Dissertation, The Ohio State University, Columbus, (1994).

surveys try to identify "what is," whereas the Delphi method attempts to address "what could/should be".[64]

In 'Delphi Analysis Method', the researcher tries "to obtain the most reliable consensus of opinion of a group of experts by…a series of questionnaires intersperse with controlled opinion feedback".[65] Questionnaire is distributed in a group of experts, at a distance OR in face-to-face group meetings, where certain people are inclined to control the process of decision making. Moreover, Delphi focus is chosen as a method of research in which the opinion of experts is analyzed. In Delphi, opinion of experts is used and it can be defined as "A method for structuring a group communication process, which is effective in allowing a group of individuals, as a whole, to deal with a complex problem".[66] In this survey, nobody 'loses face' because it is done anonymously, using a questionnaire. The research was conducted in three rounds (See Figure 0.3).

**Figure 0.3: Research design to Assess China Pakistan Economic Corridor (CPEC) in Context of Energy Crisis of Pakistan**




Source: Self-Extract

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[64] Miller, L. E., "Determining what could/should be: The Delphi Technique and its Application", Paper Presented at the Meeting of the 2006 Annual Meeting of the Mid-Western Educational Research Association, Columbus, Ohio, (2006, October)

[65] Dalkey, N. & Helmer, O. op.cit., p. 458

[66] Harold A. Linstone and Murray Turoff, *The Delphi Method: Techniques and Applications*, Reading, Mass.: Addison-Wesley, (1975), p.3

### Method of Data Collection

The Delphi questionnaire was designed to get the consensus from 16 experts (see Table 0.5) with over 15 years of energy experience to identify, and to format the causes of energy crisis of Pakistan and their reflection in the CPEC 2015.

**Table 0.5: Delphi Focused Sampling**

| No of experts | Domain | Cognate | Slot |
|---|---|---|---|
| 5 | Sciences and Technology | Sustainable Development | Energy Efficiency |
| 5 | Management | - | - |
| 6 | Social Sciences | - | - |

**Source**: Jabeen, 2016

On the basis of results of the first question in round 1 the question was constructed for second round and on the basis of results of the second question in round 2 the question was constructed for the third round (See Annexure 1).

### Observation

Data collected through structured questionnaires and extended interviews on the basis of questionnaires is analyzed and documented with an addition of personal observation.

## Significance of Research

The trends such as energy outages, high energy prices, unemployment, trade deficit, circular debt, slow economic growth and current account deficit are the indicators of energy crisis. They have affected the economic security of Pakistan. Pakistan faced the energy shortfall of 5,000-7,000MW in view of 26,000MW demand and 19,000MW supply in 2015. Pakistan has resorted to energy production policies particularly associated to foreign investment to fill the energy deficit. China took economic-strategy response to prevalent energy crisis in Pakistan and signed China-Pakistan Economic Corridor (CPEC) project in 2015. (CPEC) a project of $62 billion investment allocated 73% for energy production in

Pakistan. Focusing the aforesaid facts, it seems possible to recognize the factors responsible for energy crisis of Pakistan. The economic uncertainty created by energy crisis pushed the energy governance to ensure energy supply. It welcomed foreign investment offered by China. This research unveils the factors behind these constructs.

To assess the above variables of energy crisis the study utilizes the Institutional Theory. The institutional theory premises, "Institutions consist of informal constraints (sanctions, taboos, customs, traditions, codes of conduct), formal constraints (constitutions, laws, property rights, policies) and the enforcement dimensions of both. The constraints imposed by the institutional framework (together with the other constraints) define the opportunity set and therefore the kind of organizations that will come into existence" (North, 1990). The framework evolves with the combination of both. This research has developed a theoretical construct to describe the relationship between the dynamics of energy crisis and energy governance linked with energy projects. The research extends its value of business incentives from intra state level to interstate level. That becomes an addition into the literature of institutional theory.

This study presents data by using 'Delphi Analysis' method that includes: causes of energy crisis, energy governance and energy specifics of CPEC to ensure affordable and clean energy as endorsed by the UNO 7$^{th}$ SDG. The study would be useful to enable government of Pakistan to ensure energy crisis management that will improve quality of life of the people of Pakistan; through enhanced socio- economic development opportunities.

## Organization of Study

The study is organized in five chapters along with introduction and conclusion. Chapter 1dilates the concept of energy security and energy crisis in general and then describes the energy crisis of Pakistan in specific by using the Energy Security Index (ESI). Chapter 2 presents theory of institutions in intra state and interstate economic relations, and its application on energy crisis of Pakistan. Chapter 3 discusses the causative factors of energy crisis including climate change impact, population pressure and inefficiencies in energy governance. Chapter 4 discusses dynamics of energy governance and energy crisis of

Pakistan. Chapter 5 explains China-Pakistan Economic Corridor in Flash of Energy Crisis of Pakistan and provides energy specifics of CPEC described in terms of Affordable and Clean Energy as written in the $7^{th}$ Sustainable Developmental Goal of UNO. The study concludes with findings and recommendations.

# Chapter 1

# Dimensions of Energy Security and Energy Crisis

## I. Energy Security

## II. Measuring Energy Security

1. Energy Production Dependency
2. Energy Supply Certainty
3. Energy Affordability
4. Energy Sustainability

## III. Energy Crisis

High Energy Deficit

High Energy Prices

High Environmental Costs

High Production Costs

# Chapter 1

# Dimensions of Energy Security and Energy Crisis

Energy crisis claims significant relationship with the decisions and actions of energy governance at national and international levels. Academic interest in the energy security has been found elevated in international politics particularly since the energy crisis of 1973. The reason is growth in energy demand because of dependency of human generation on energy revered socio-economic and industrial development. As a result, the energy profile (demand and supply) of countries is counted to refer their quality of life and economic growth (See Table 1.1). Every state surge to enhance the energy security. The affordable and clean energy is ultimate to economic development and welfare of the society endorsed by the7$^{th}$ Sustainable Developmental Goal of UNO.

**Table 1.1 Per Capita Energy Consumption in Kw/h (2018)**

| Sr. No | Country | Per Capita Energy Consumption |
|---|---|---|
| 1 | Kuwait | 19,062 |
| 2 | Canada | 15,546 |
| 3 | US | 13,250 |
| 4 | Australia | 10,071 |
| 5 | France | 6,940 |
| 6 | China | 4,475 |
| 7 | India | 806 |
| 8 | Pakistan | 471 |

**Source**: The World Bank, 2018

Chapter 1 has analysed different perspectives of the concepts of energy security by elaborating on the conventional definitions having specific scope. An account of the concepts of energy security is highlighted through the prisms of scholarly research work, organizational definitions, and political debates. The Energy Security Index (ESI) has also been described and applied on the energy security of Pakistan. The comprehensive and well-defined indicators of ESI have helped in the presentation of the quantifiable view of energy security. The concepts of “Energy” and “Security” have been explained separately before presenting the concept of “Energy Security” for a better understanding. The study initiates its premise via following question:

**Why energy security is central for competition and cooperation in international system; and how national-regional-international economic factors inflate challenges in the process of energy security?**

The significance of energy for human life was established since the ancient times and has been used to sustain human life on earth. The sources, as well as the use of energy, became diversified with scientific advancements. Coal powered machines were built during the Advanced Agricultural era to collect water and wind. This water and wind were used for operating flour mills and sailing the ships during the early Renaissance era. Later, the steam engine was introduced in the industrial Revolution period in which coal, wood, and hay were utilized by the industrialized nations for the generation of steam in the steam engines and this steam transformed the heat energy to mechanical energy which ultimately employed in a range of ways. The energy efficiency was achieved with the introduction of internal combustion engines employing a diverse variety of energy sources.

In the late 20$^{th}$ century, energy has been believed to be the most vital component which has impacted the shape of the society. The quality of our lives is significantly impacted by the availability, accessibility, and affordability of energy sources. Over two decades ago, the stability and sustainability of our environment; the (reciprocal) link among economic development and energy; health of national economies; and inter-state relationships were more concretely established in the international development realm. Though energy established as the fuel for the economy but energy, along with its components and flows, is dependent upon the finances being provided by the economy for the proper working of energy systems. The most important fact which was grasped by the Western Allies at the end of the 2$^{nd}$ World War was the energy need of Germany which forced it to make it the top priority target and the key scientific objective to ensure the availability of the energy for the industry.

Till 1940, the world had been kept dependent upon the coal, firewood, and oil for the generation of energy. As a result of the technological advancement, the first-ever commercial nuclear power plant was developed on a shipping port at Ohio River, Pennsylvania which started its operations in 1957 with the electric power generation

capacity of 60 megawatts.[67] In the mid-20th century, the hydropower from dams was commercialized while the contribution of natural gas in the energy mix was inducted at the end of the 20th century. Meanwhile, the global energy mix experienced the appearance of the alternative sources of energy like biomass, geothermal, solar, wind, and waste in the early 21st century. Despite the fact that the fossil fuels are still the main sources of electrical power generation, the world is witnessing the growing concerns regarding the environmental impacts due to their combustion and their depleting resources all over the world. Thus, their governance of energy resources is surrounded by its development, economic, environmental, political, resilience, security, and social impact in consideration.

The energy experts have used different terms for the classification of energy generation systems established on their sources which include alternative/customary, renewable/non-renewable, and conventional/non-conventional energy generation systems. It is important to highlight that the conventional energy generation systems are most of the time fully developed systems while the non-conventional ones are the energy generation systems which use renewable resources and are functional but going through the research and development process. The commonly used customary systems for the energy production in a country are the conventional systems. Despite the fact that the Hydro/Hydel energy production systems utilize the water which is a renewable resource but still this system is categorized as the conventional system of energy production thus being called as both renewable and conventional production systems.

In the present era, the modern economy is fundamentally defined by the access to the modern forms of energy which are relatively clean, secure and affordable. The significance of energy is clearly highlighted by the facts that it is one of the basic needs of all individual and also a tool to measure the personal living standards and quality of living as the per person consumption of energy is directly linked with the quality of life according to the Human Development Index (HDI). The HDI quantitatively measures three categories i.e., Gross Domestic Product (GDP), Education, and life expectancy to measure the quality of individual's life. The key factor in this regard is energy around which almost every need of modern society and economy is revolving. It is important to

[67]Raymond L. Murray, *Nuclear Energy: An Introduction to the Concepts, Systems, and Applications of Nuclear Processes* (Boston, Massachusetts, Butterworth-Heinemann 5th Edition, 2001)

understand the concept of "Energy Security" in an effective way, thus a discussion is presented in the subsequent part upon the concept of "Security".

In the state of nature, the life of man was "solitary, poor, nasty, brutish, and short." Since the moment the realization was made by the very first Homo Sapiens that instead of surviving alone, it is much easier to survive in a group thus entering into a mutually agreed social contract, forming a civil society, and willingly surrendering the authority to a sovereign entity for the peaceful co-existence and evolution of clans, society and nations has emerged. The embracing of various roles was re-established within this loosely bound collection of individuals by the members in order to guarantee the overall survival of the society. Therefore, the far-sighted and wise individuals were given the responsibility of governance, authoritative menial occupations for the fulfilment of needs of the society and came under the domain of majority while the few among the clan who were strong, brave and dynamic in both deeds and thoughts were chosen for the defense. Hence, the armies constituted of the noble individuals entrusted with the responsibility of securing the society from external dangers.

The term security is not only politically but also scholarly contested concept, hence it is declared to be only "insufficiently explicated" by Baldwin.[68] Over a course of time, the concept of security remained to be associated with the preservation of the territorial integrity of the countries as this conception was also strengthened by the Treaty of Westphalia. The security remained to be defined as the study of the threat, control, and use of military force in the perspectives of security studies under the traditionalist approach as this notion was characterized by the narrative of Walter Lippmann that the security of a nation is secured if it is able to preserve its core values either through the successful execution of deterrence or through military conquest.[69]

Romano Prodi, the Italian Prime Minister, in 1997 affirmed: "the problem of the safety of the country seems to be no longer one of external safety, but an internal one: the

[68]David A. Baldwin, "The Concept of Security", *Review of International Studies,* Vol. 23, No. 1, (1997), pp. 5-26

[69]Walter Lippmann, *U.S. Foreign Policy,* (Boston: Little, Brown and Company, 1943), P. 51

safety of citizens in their everyday life".[70] Although it was apparently a reference to the crime by Mr. Prodi but this statement further deepens the concept of security.

Richard Ullman was one of the first among other scholars of security studies who supported the inclusion of a wide range of threats mainly environmental degradation, diseases and natural disasters in the concept of security with its expansion.[71] Ironically, this expanded concept still persisted to be military oriented and state-centric in its true essence. There are five distinctive structures that are considered as the core elements of national security under this characterization.

- Ensuring the survival of the nation and state as a political entity, and the physical existence of its people;
- Safeguarding the integrity of the territorial boundaries of the state as the basic right;
- Ensuring the political liberty as a component of the globally acknowledged national status of the state;
- Ensuring the living standards;
- The national security policy must incorporate the 'vital interests' of the state.

The national security got much broad and wider meaning after the advent of globalization which transformed from "the integrity of the territory of a nation"[72] and freedom of a state from the other. Although sovereignty doesn't remain sacred, likewise security is not considered as a purely national concept. Thus, national security is broadly considered as a condition where the institutions, sovereignty, territorial integrity, peoples' way of life as well as their well-being and welfare are enhanced and well protected, as pointed out by Robert McNamara:

> Security means a development in modern society. Though security may include military hardware but it doesn't revolve around it; security may include the use of military force but it doesn't revolve around it; security may encompass traditional

[70]Quoted in Dario Melossi and Rossella Selmini, "Social Conflict and The Microphysics of Crime: The Experience of the Emilia-Romagna Citti Sicure Project," (London: Routledge, 2000), p. 161
[71]Barry Buzan, *People, States* & *Fear: An Agenda for International Security Studies in the Post-Cold War Era* (Chapel Hill: UNC 1991), p. 17
[72]Hans Morgenthau, *Politics Among Nations: The Struggle for Power and Peace* (New York: Alfred A. Knopf, Fifth Edition, Revised, 1978)

military activity but it doesn't revolve around it. There can be no security without development thus security is development. In fact, the developing nation who become unable to develop simply be unable to stay secure due to various obstinate causes because its own people failed to shed the human nature of their state.[73]

The scale of statist, national and military oriented national security in parallel security paradigm has expanded surrounding the host of other complementary aspects as illustrated in the application of security as a military instrument was the focus of traditional paradigm while in the contemporary modern era; security is achievable through the collective application and interplay of all the national power elements.

In international relations, security is the prime motivation and chief concern of all the states. Though, in the existing literature, it is hard to find any mutually agreed definition of the concept of security rather diverse explanations are available as mentioned in the above discussion. For few scholars, the cause behind the absence of this definitional consensus is that the motivations behind the defining security possibly differ amongst various scholars, people and/or nations influenced by a different set of situations, the scope of the threat perception and/or precautionary measures. Likewise, successful results cannot be generated through the implementation of a single definition on all individuals or nations in all circumstances. This study takes "Energy" as it the primary focus of "Security" among all other dimensions of security. After separately defining "Energy" and "Security", the following part has attempted to coin both concepts as "Energy Security".

## I. Energy Security

Conceptual Development of the Energy Security: For more than a century, energy security emerged as a reality of international life. Sir William Stanley, lecturer and then Professor of Economics at the Queen's College of Liverpool, was the first person who gave the first serious call to draw the attention of the world towards the rapidly depleting natural sources of energy primarily coal with the publication of his famously alarming paper titled, "The Coal Question: An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of our Coal-Mines." It was assumed by the Jevons' Paradox that the technological advancement is associated with the increased energy efficiency as the

[73]Robert S. McNamara, *The Essence of Security: Reflection in Office*, (London: Hodder & Stoughton, 1968), p. 149

development of economic, social and technological systems and rises in the quantity of energy utilizing devices would be resulting in a rapid increase in the energy utilization patterns rather decreasing its consumption.[74] Therefore, energy security emerged as a research topic for lots of managers, policymakers, academic researchers, scientists, and citizens as well.

Strangely, the energy community has not been able to agree mutually acceptable definition of energy security. Criticism has remained for the narrow definitions due to their focus on primary fuel (avoiding conversion technologies), oil (ignoring other sources of energy) and imports (evading the domestic infrastructure).Conversely, energy security is generally used as "provisioning of short and long term uninterrupted energy services in an affordable, efficient, environmentally friendly, and equitable manner".[75] International Energy Agency established in 1973 by the Organization for Economic Cooperation and Development (OECD) member states which, for the first time, agreed on the concept of energy security as 'a sustainable, stable and reliable energy supply.'

Three distinctive objectives of energy security have been identified by Samuels.

- Decreasing the vulnerability to foreign pressure and/or threat,
- Preventing the occurrence of a supply crisis,
- Reducing the military and economic impacts of a supply crisis after its occurrence.

Contrary, the "4R's" of energy security were introduced by Hughes i.e.

- Review (Comprehension of the issue)
- Reduce (Less energy utilization)
- Replace (Switch towards secure resources)
- Restrict (Control emerging demands for resources prevention).

[74]William Stanley Jevons, *The Coal Question: An Inquiry Concerning the Progress of the Nation and the Probable Exhaustion of Our Coal-Mines* (London: Macmillan, 1866)

[75]B. Sudhakara Reddy, "Sustainable Energy Security for India - An Indicator-Based Approach", in *Energy Security and Development*, ed. B. Sudhakara Reddy and Sergio Ulgiati (Springer: New Delhi, 2015), pp. 3-38

The role of energy security from the perspective of renewable energy has been discussed by Valentine.[76] The contact among energy and economy spread over the four A's of availability, accessibility, acceptability, and affordability has been discussed by Asia Pacific Energy Research Centre (APERC). Energy Security is defined by APERC as, the capacity of an economy to ensure the supply of energy resources in a timely and sustainable manner with such a pricing level which must not negatively impact the economic performance of that economy, extended over the four A's of availability, accessibility, acceptability, and affordability.

The concept of energy security has been suggested by Sovacool and Mukherjee to improve the situation of energy supply continuity.[77] Energy security has been defined by the International Atomic Energy Agency (IAEA) as "uninterrupted physical availability at a price which is affordable while respecting environmental concerns."[78] Similarly, it is articulated by Hans-Holger et al as:

> Protected supply of fuels along with the imports, technologies that ensure the sustainability and self-sufficiency altogether with the security against disruptions, as well as those which border against instability in prices, supporting the source and technological diversity, and limiting the threats from and to bordering countries.[79]

Energy security is defined by Yergin, one of the most prominent global voices on energy, as, "reliable and affordable access to energy supplies, diversification, integration into energy markets, and the provision of information." In the international relations perspective of energy security, he added that it is "Lodged in the larger relations among nations and how they interact with one another."[80] (This particular point will be further discussed in the following chapter of this research in greater detail). According to Bernard

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[76]Scott V. Valentine, "Emerging Symbiosis: Renewable Energy and Energy Security", *Renewable and Sustainable Energy Reviews*, Vol. 15, No. 9 (2011), pp. 4572-4578

[77]Sovacool, & Mukherjee, "Conceptualizing and Measuring Energy Security", *Energy*, Vol. 36, (2011), pp. 5343-5355

[78]IEA, "Energy Security," International Energy Agency (2011). Available At: http://www.iea.org/subjectqueries/keyresult.asp?KEYWORD_ID=4103 Access On: 30-10-2017

[79]Hans-Holger Roger, et al., "The Costs of Energy Supply Security", *International Atomic Energy Agency and IAEA*, (2006)

[80]Daniel Yergin, "Ensuring Energy Security," *Foreign Affairs*, Vol. 85, No.2, (March/April 2006), pp. 69-82

D. Cole, "The availability of energy at all times in various forms, in sufficient quantities and at affordable prices".[81]

Energy has played an important role in human empowerment and development since the industrial revolution where a two-way relationship has correlated among each other. The production capacity is enhanced with the higher use of energy and thus improves all standards of development mainly the improved lifestyle and economic growth which ultimately leads to the higher utilization of energy. On the other hand, production and consumption of energy play a pivotal role in various issues of sustainability like depleting natural resources, climate change, and the local air pollution in the indoor and outdoor spheres.

The demand and supply aspect of security is not the only dimension of energy security rather environmental impacts are also included in energy security. The ownership of and control over the country's energy resources implies as energy security affirming variations both in terms of reserves and consumption among the renewable resources. The sustainable economic growth is essentially dependent upon the availability of energy sources and the reliability of their supply. The security situations such as geopolitical tensions impact the heavy energy import dependency which often resulted in the disruptions of supply as happened in the Arab-Israel conflicts, Iraq war in 2003, and Russia and Ukraine dispute over gas reserves in 2005-2006.

The provision of accessible, affordable and sustained energy services to the consumers concerning the efficient and equitable supply of energy has to be ensured. In both demand and supply aspects of environmental compliance, it is crucial for sustainability especially in terms of ecological impacts, air pollution and climate change in the long run. Apart from the adverse impacts of the use of fossil fuels in terms of greenhouse effects, the acidification of land, deforestation which is ultimately resulting in erosion, loss of soil and its degradation due to energy activities and subsequently can impact agricultural productivity.

The issue of energy security is a high priority scientific and political agenda in the developing and industrialized economies of the world. Energy security is more cause of

[81]Bernard D. Cole, *Sea Lanes and Pipelines: Energy Security in Asia*, (New Delhi: Pentagon Press, 2008), p. 3

concern for the developing economies of the world as they represent around two-third of global increase in the energy consumption and increase of three forth in $CO_2$ emissions through 2010-2030.[82] A crucial challenge in attaining the human development of around 2.4 billion populaces living in these developing countries due to prevailing energy deficit and currently experiencing no or unstable access to energy resources and being impacted by the increase in the prices of energy and ultimately effecting their affordability; moreover, the high climate change vulnerability of the developing countries is a growing global cause of concern as according to various predictions, climate change will cause greater risks of life and health along with the shortages of food and water for billions of people living in these regions.[83]

Energy is a precondition for commodities equating air, earth, and water rather than being a substitute for them. Energy security is believed to be vital for human security as postmodern lifestyles and modern economies are dependent upon energy services. The efficient diversification and use of available energy resources are considered as a key to energy security. The existing resources of fossil fuels are rapidly depleting according to the prediction of Jevons' paradox. On the other hand, the world is still hoping to prolong the era of fossil fuels through the evolution in the smooth evolution of discovery of new sources of energy, new extractions of existing energy resources, conversion technologies, and energy conservation strategies. Instead of controlled global downsizing of societies, population, and economies, the new arrangements can be helpful in additional growth of energy supported by the newly discovered sources of energy.

Therefore, energy security becomes a blend of interpretations when it is compared amongst different nations and regions during discussions. The purpose, importance, and meaning of energy security are completely different for the energy deficit developing nations like Pakistan where the energy demand is surpassed by the energy supply. Hence, the primary objective of Pakistan is to meet its energy requirements and to fill the constantly increasing demand and supply gap of energy in order to attain energy security within the country. On the other hand, the concept of energy security appears in a completely different meaning for energy sufficient countries as sources of energy are

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[82]Nebojsa Nakicenovic, "World Energy Outlook 2007: China and India Insights", Paris: IEA/OECD, (2007)
[83]Sumudu Atapattu, *Human Rights Approaches to Climate Change: Challenges and Opportunities*, (New York: Routledge, 2015)

adopted as a medium of politics by them. This notion is evident by the Arab-Israel war of 1973 when oil rich Arab states used oil as a soft weapon and thus interpreting energy security through a different perspective.

To summarize, it is important to highlight that the access to affordable, clean, reliable and sustainable sources of energy can exert significant impressions on various dimensions of human development and life. Therefore, the attainment of energy security is necessary for eluding significant vulnerabilities but also vital for human development. The energy demand for human development has endlessly grown along with the advancement of human civilization. In this regard, a resilient energy security system is essential to meet the technological and infrastructural advancement which not only consists of protected physical infrastructure mainly energy supply lines besides affordability, commercial capacity, and consistency of energy. In a realistic manner, the aim is to provide energy services to domestic customers and industrial zones that are aligned with the spending capacity of the client. The debate until now clarifies the evolution, refinement, and expansion in the concept of energy security with the passage of time along with the absorption of several dimensions in it.

## II Measuring Energy Security

In order to have a better understanding of the status of energy security in Pakistan, Energy Security Index (ESI) has been applied as a yardstick in the following part of this chapter. Four indicators are defined in this index which is defined in the following table 1.2.

**Table. 1.2 Energy Security Index**

The ESI measures the energy status of states in three dimensions:

1. Energy Production Dependency: Know how, as measured by availability (one third weight) and utilization (one third weight) of energy resources as per set of politics (one third weight).
2. Energy Supply Certainty: A certain supply of energy, as measured by costs incurred to insure the security of energy supply.
3. Energy Affordability: Affordability as measured by per capita energy consumption at purchasing power parity (PPP) in USD.
4. Energy Sustainability: Environmental safety as measured by environmental impact assessment.

**Source**: Musarrat Jabeen, "South Asia and Governance of Energy Security", *Regional Studies*, Vol. XXIV, No.3 (2006)

## 1. Energy Production Dependency

Energy production dependency is realized production reliant upon knowhow as measured by the availability of energy resources (one-third portion) and its consumption (one-third portion) according to the devised policies (one-third portion). The level of energy potential is measured by it and further identified that to what level this potential can be exploited. From this point onward, the discussion has been diverted to Pakistan's perspective of energy production dependency from the international perspective of energy dependency.

Presently, fossil fuels including oil have the highest share in the energy generation mix which is 32.1% while gas has a 33.6% share.[84] Fossil fuels which are made by the diagenesis i.e., death, decay and transformation – a natural process which involve the heat from the core of earth along with the pressure exerted by soil and rocks on the fossils of dead creatures and plants and in this process fossil fuels mainly coal, crude oil and gas is produced. The process of chemical and physical changes associated with compaction and lithification is called Diagenesis. On the other hand, lithification is the process that is associated with the transformation and hardening of sediments into stone through the movement of various minerals into sedimentary pore spaces.

The most significant and primary form of fossil fuel is coal. During the era of the industrial revolution, coal was the fuel of choice and was the first and mostly used fossil fuel on a large scale to generate steam to run steam engines and turbines. The 16$^{th}$ century Britain was the first major economy in the whole world which utilized coal for industrial purposes as it was reliant on woods before it switched to coal.[85] Coal is thermally decomposed at the level of temperature around 600°C to 800°C while in coal gasification, the large coal molecules are transformed into gaseous fuels which are products of a carbon rich char and methane that are utilized as a primary and/or secondary energy resource. Roughly, this gaseous produced is classified into 4 main categories: anthracite, bithuminous, sub-bithuminious, and the last one is lignite. The finest category among all these types of coal is anthracite coal which has more carbon elements. The normal category of coal consists of bithuminous and sub-bithuminious coal, whereas the lowest

[84]Government of Pakistan, Ministry of Petroleum and Natural Resources, Hydrocarbon Development Institute of Pakistan, *Energy Year Book 2017* (Islamabad, 2018)
[85]John S. Dryzek, *The Politics of the Earth: Environmental Discourses* (Oxford University Press, 2013)

quality of coal is lignite because of having fewer elements of carbon and more elements of oxygen and hydrogen.

The total coal reserves in the world are estimated at around 869 billion tons. The largest confirmed reserves of coal by region are in Asia pacific whereas the second largest coal reserves are in North America. Almost 90% of the global world production of coal is accounted for the top coal producing countries mainly Australia, China, India, Indonesia, and Russia among other five top coal producing countries. The largest producer of coal around the world is China, its production of coal is estimated at around 1747.2 million tons and also accounted to be the largest global consumer of coal with 1892.6 million tons while the second position has been given to the United States in this ranking. Currently, coal is being utilized for 40% of global energy production. Ironically, there are huge coal reserves of Pakistan just like other coal-rich countries but its industrial needs are managed by the import of coal from other coal producing countries. The coal imported by Pakistan Steel Mills for its utilization as coke during the fiscal year 2016-17 was valued at $81,280 million. Pakistan is ranked 7$^{th}$ for its coal reserves and there is huge potential for the utilization of its own reserves to overcome the country's energy crisis. In comparison to the average 40% share of coal in the global energy mix, the share of coal in the energy generation mix of Pakistan is at very low. Currently, the share of coal in the energy generation mix of Pakistan is only 0.2%. The estimated reserves of coal in Pakistan including hypothetical, inferred, indicated and measured are around 186 billion tonnes[86] which are categorized as sub-bithuminious to lignite. Around 95% of these coal reserves were discovered during the early 1990s in the Thar coalfield which holds coal reserves of around 175 billion tones which classify this coal field as the 7$^{th}$ world's largest coal field. The category of coal found in Thar is brown coal generally known as lignite which is the softest and lowest category of coal having 29.6% to 55.5% moisture content which is the highest among all other categories.[87] Prior to its usage, it needs to be dried and then can be utilized as a fuel in supercritical plants. Contrary, other obstacles in the exploitation of coal reserves consist of deficient finances, weak infrastructure, and lack of modern technological skills of coal mining.

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[86]Government of Pakistan, *Energy Year Book 2017*, p. 89

[87]Government of Pakistan, Ministry of Petroleum and Natural Resources. Hydrocarbon Development Institute of Pakistan *Energy Year Book* 2015

The first coal fired power plant was the Quetta Power Plant which was constructed in 1963 with the support of USAID at Sheikh Mandah near Quetta. The cumulative capacity of the plant was 15MW and consisted of two units of 7.5 MW. The fuel used in this plant was Pulverized Coal Technology along with the sub-bituminous form of coal which was mined from the hard range mines of Baluchistan. After completion life span of 20 years, both of its plants were closed in 1980s by WAPDA. With the assistance of Dongfang Electric Corporation Limited (DECL) a Chinese company, another plant was constructed in District Jamshoro near Khankot.[88] Currently, sincere and intense efforts have been made by the government of Pakistan for introduction and utilization of coal in the power sector and thus taxes and duties applicable on required machinery and related technologies are exempted.

Oil has been used by humans for thousands of years. Oil was collected from surface outflows in small amounts about 3000-2000 BC by the Middle Eastern Civilizations mainly Mesopotamia and Egypt. This oil is then utilized for construction of buildings, mummification, setting jewels, waterproofing boats, and other structures. The Pennsylvania Rock Oil Company of Connecticut, United States was the pioneer in the modern drilling techniques when George Bissell along with other investors established a company in mid-1850. On August 27, 1859, the first oil well was drilled successfully which later increased to seventy-five oil wells in just fifteen months after it and thus the company was producing 450,000 barrels of oil annually. The production was increased to three million barrels by 1862[89] and by 1909, daily half a million barrels were individually produced by the United States. It was more than the combined oil production of the rest of the world. The United States was the supplier of half of the world’s oil demand with the successive discoveries of oil reserves in South and Central America, and later, this share was significantly reduced by the discoveries of oil reserves in the Middle East.

Pakistan consumed 350,000 barrels of oil during the fiscal year 2006 and 80% of the oil is imported by the government. Currently, 6,785 MW of energy is being produced through the utilization of oil as 32.1% of the total energy produced in Pakistan in the year 2017 was through oil resources. The energy mix around the world has a meagre share of

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[88]Power Generation Company Limited (LPGCL), “Introduction from LPGCL-Lakhra”, Available At: http://lpgcl.gov.pk/ Access On: 10-10-2018

[89]Jack J. Kraushaar& Robert A. Ristinen, *Energy and Problems of a Technical Society* (New York: Wiley, 2nd Edition, 1993)

oil in the energy production as UK has 0.6%, US 0.9%, India 1.7% and Bangladesh 16.4% of the share of oil in energy generation.[90]

Natural gas is formed through the same process alongside of oil and coal and found deep under the surface of the earth. It is mainly composed of methane along with different amounts of other higher alkanes besides occasional percentages of helium, hydrogen sulphide, nitrogen, and carbon dioxide. Natural gas moved into large spaces and cracks during the compression process and stored among the tiny pores and/or overlying layers of rocks among some formations of sandstone, shale and other forms of sedimentary rocks where it is commonly known as tight gas or shale gas. The gas reserves which are formed in the coal deposits are generally referred as coal bed methane. Gas Hydrates are a relatively clean source of energy as its commercial potential can be utilized in the industry which can change the general perception about it as it is commonly considered as troublesome for gas and oil field operations. The permeabilities of gas shakes and tight gas are considered low due to its milli-tarchy fraction (less than $10^{-15}$ $m^2$) thus its production at an economical rate is a troublesome task.

Comparatively, Gas is a low-cost source of energy and has an enormous share in the energy mix of Pakistan just like oil. By 2017, around 32.45% of the energy needs of the country were fulfilled by the utilization of gas reserves. As of June 2017, the total reserves of natural gas with Pakistan were estimated at around 1377 Billion Cubic feet. The natural gas which is produced annually within the country is consumed by the domestic households thus the current production becomes insufficient to meet the energy needs. The production of natural gas was 42.0 Billion Cubic Meters while its usage rate was exactly the same during the year 2014-15.[91]

Nuclear technology has been extensively used for the production of energy other than the fossil fuels. Nuclear energy is a non-renewable source of energy which is produced through uranium by splitting of its atoms to generate heat through a process known as nuclear fission. The enormous destructive capacity of nuclear power was first presented with the dropping of two nuclear bombs on Nagasaki and Hiroshima in 1945

[90]Ameena Sohail, "Review of Energy Sector with Focus on Energy Tariff Determination", in *Solutions for Energy Crisis in Pakistan*, ed. Mushir Anwar (Islamabad: IPRI, 2015), p. 22
[91]British Petroleum, *British Petroleum Statistical Review of World Energy*, (2016)

during the World War II which killed 80,000 to 140,000 people and seriously injured 100,000 people in a blink of an eye. This destructive capacity of nuclear technology forced the world to realize the constructive and peaceful use of it since then and thus the fusion technology has been vigorously explored ever since despite not mainstreaming it commercially.

Nuclear energy has been utilized for the generation of energy by a large number of developed and developing countries. Currently, there are 454 operational Nuclear Power Plants (NPPs) with an installed capacity of 400285 MW in 30 countries of the world. The United States is currently the top large-scale producer of energy using nuclear power. According to estimates, nuclear power shares 11% in the global energy mix. There are around 54 NPPs in seventeen countries which are under construction.[92] In Pakistan, the current installed capacity of nuclear power is 1355 MW which is produced by five NPPs mainly KANUPP-Chashma-1 (C-1), Chashma-2 (C-2), Chashma-3 (C-3) and Chashma-4 (C-4) which are contributing a share of around 5.5% of the energy mix of the country. Pakistan is presently constructing two more nuclear power plants. China is the only country in the world which is supporting Pakistan in its civil nuclear programme as Pakistan is not a party to the Nuclear Suppliers Group thus it could not get nuclear assistance from the world. In the Energy Security Plan 2005, the government of Pakistan has presented its commitment to increase the nuclear power generation capacity and 8.800 MW by 2030. The Nuclear Power Programme 2030 was revised and it is aimed to increase the capacity of nuclear power up to 42000 MW by 2050 after the inauguration ceremony of C-2 at Chashma on 12$^{th}$ May 2011.[93]

There are two types of hydropower plants i.e., reservoir based and run-of-the-river plants. Construction of dams is required for the reservoir-based hydropower plants whereas they are also exploited for the flood control, irrigation and likewise purposes. Ten, the water releasing from these dams through their spillways is then utilized for the hydel energy production. The energy generated through the hydroelectric process in the world is estimated at around 15.9% while its present contribution is 30.4% in the global

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[92]IAEA, "Power Reactor Information System (PRIS)", *International Atomic Energy Agency*, (2019)
[93]"Nuclear Power in Pakistan", *World Nuclear Association (WNA*), Available At: https://www.world-nuclear.org/information-library/country-profiles/countries-o-s/pakistan.aspx Access On 25-10-2018

energy mix. The share hydropower in energy generation is high in African countries which are 54.2%, Brazil has 62%, Canada has 57%, Norway has 54%, and Venezuela's share is 74%.[94]

The hydropower potential of Pakistan is around 60,000 MW due to its water system which is ranked 5th in the world. With the inclusion of categorized sites having hydropower potential of 55,000 MW, the overall hydropower potential of the country reached to more than 100,000 MW. Ironically, only 11% of this potential has been utilized while the exploitation of the rest of the potential is yet to be harnessed. The hydropower projects in Pakistan are installed in Chashma, Ghazi Brotha, Mangla, Tarbela, and Warsak. There is immense potential in AJK, GB, and KPK to construct run-of-the-river hydropower projects. The present hydropower capacity in Pakistan is 9,623 MW while its share in the total energy mix is 30.29%.[95]

Renewable Energy: The energy which is acquired from a natural resource at the cost which is cheaper or at least equal in the cost. The energy source mentioned above is the non-renewable form of energy resources as it is quite difficult to recreate its resources. Presently, the international energy production has a huge share of non-renewable energy sources but adoption of the renewable sources is becoming the new trend. The primary sources of renewable energy resources are hydropower (energy from flowing water), Solar (energy from the sun), wave/tidal (energy from sea/ocean waves and tides), Wind (energy from winds), and Geothermal (energy from the heat inside the earth).

Historically, the wind has been used as an energy source for thousand for years especially for driving windmills, sailing and likewise with reliance on the physical attributes like atmospheric pressure. The power of the wind that can be utilized for the conversion of mechanical energy into electrical energy has a maximum percentage of an estimated 59.3% of wind power depending upon the efficiency of the rotor blade.[96]

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[94]Bob Dudley, "BP Statistical Review of World Energy 2018", Available At: https://www.bp.com/en/global/corporate/news-and-insights/press-releases/bp-statistical-review-of-world-energy-2018.html Accessed on 19-10-2018

[95]"Hydro Power Resources of Pakistan", *Private Power & Infrastructure Board (PPIB)*, (2011), p. 93

[96]John R. Fanchi and Christopher J. Fanchi, *Energy in the 21st Century*, (London: World Scientific Publishing Company, 2016), p. 234

In order to evaluate the energy potential of wind in Pakistan, various locations were surveyed in the southern regions of Baluchistan and Sindh in collaboration among the Alternative Energy Development Board (AEDB), Pakistan's Meteorological Department (PMD), and National Renewable Energy Laboratory. The estimated total capacity of energy through wind stands at 691 MW whereas the generation capacity was 1,326 GWh as of 2016-17.[97] The five major wind energy production projects as of 2015 were Foundation Wind Energy- I Ltd, Foundation Wind Energy – II Ltd, FFC Energy Ltd, Three Gorges First Wind Farm Pakistan (Pvt) Ltd, and Zorlu Energi Pakistan (Pvt) Ltd.

The solid wastes of agriculture and plants, animals, and municipals generally produce biomass which has daily estimated the production of agricultural remainders are around 225000 tonnes, around one million tons of animal manure and around 50,000 tons of municipal solid wastes are produced. Though energy production through biomass is a very cheap and inexpensive source of energy just like other renewable resources but, similarly to solar and wind energy, it cannot be used on a larger scale. Biomass is capable of producing a massive amount of clean energy without causing higher concentrations of carbon dioxide and various other emissions of greenhouse gases. The agricultural residue is produced on a large scale due to the agricultural economy of Pakistan. There are finest favourable conditions for the energy generation through biomass in the rural areas but the large quantities of municipal waste being produced on a daily basis in the urban areas can be harnessed for the energy generation. The annual generation capacity of stringy residue is estimated at around 5700 GWh.[98]

There are plans of the Alternative Energy Development Board (AEDB) to produce 10 MW of energy in Karachi through the utilization of municipal waste while the same plans are believed to be executed in various cities of Pakistan. There is the potential of 1800 MW of energy generation from sugarcane and 500 MW potential from waste-to-power as estimated by AEDB in collaboration with international institutions like Risoe (Denmark) and NREL (USA). The Framework of Power Co-generation 2013 (Biomass) was announced by the Government of Pakistan on the recommendation of AEDB in order to utilize the sugar mills industry's potential for the generation of energy as the waste

[97]Government of Pakistan, (*Energy Year Book 2017*), p. 97
[98]Kamran Yousaf Awan and A. Rashid, "Overview of Pakistan's Energy Crisis: Generation-Mix and Renewable Energy Scenarios", *International Journal of Engineering and Technology*, Vol. 1, No.4, (2012), p. 330

produced by this industry can be utilized for enough power generation for the sugar mills industry. In this regard, M/S Chiniot Power Limited is constructing a power generation capacity of 62,4 MW while Letter of Intent (LoI) has been issued to nine sugar mills and companies which are in various phases of construction while their cumulative capacity is around 271 MW. The energy generation through Bagasse/biomass during 2017 was 928 GWh while the present overall capacity is around 281 MW.[99]

The source of energy that is unlimited and abundant in nature is sunlight which is being utilized as the fastest growing renewable technology for the generation of energy. It is been almost five billion years since the energy has been originating from the sun. The climate and geographic conditions of Pakistan make is the most ideal country for the development of solar energy as more than 95% of the total area of the country accumulates 8-10 hours of sunshine each day while the average potential of solar energy in the country is 5.5 – 8 kW h/m$^2$/day. Ironically, energy production through solar energy is 635 GWh despite the overall capacity of 400 MW in the country.

From the perspective of rising demands of energy in Pakistan, the potential of fossil fuels except coal is insufficient and thus it is difficult to meet overall factors of energy dependency in the country. Ironically, there is a huge abundance of coal in Pakistan but the below-average infrastructure for its utilization for energy generation is a real obstacle. A brief but comprehensive account of impediments in the utilization of nuclear energy is discussed above among other renewable sources of energy and thus a clear picture of choice among energy resources is presented. Strangely, the expensive gas and oil with higher import dependency have been made as a source of energy generation choice due to various political reasons. On the other hand, the significance of renewable resources except hydel power has been completely neglected to share their contributions in the overall energy mix of the country. Table 1.2 provides an account of solar energy generation potential but it is not harnessed to its real potential. The political mind-set and utility of energy are the factors which cause the low energy production in Pakistan.

[99]"Pakistan Energy Yearbook", *Hydrocarbon Development Institute of Pakistan*, (2017), p. 236

## 2. Energy Supply Certainty

The certainty measures in energy supply refer to the supply of energy is being ensured or not. After the production of sufficient energy, the next step is to transmit the energy to the customers. It is indicated by both ground realities and scholarly researches that the focus has been given to the increase in the production of energy but the foremost needed aspect which is transmission and distribution of energy has not been attended as a priority. The failure of the systems of transmissions and distributions has been correctly pointed out by Bhutto, Bazmi, and Zahedi. Whereas, the need for modernization of existing energy transmission and distribution systems have also been emphasized by Khalil and Zahidi.[100]

Contrary, a remarkable progress has been witnessed in the energy generation capacity after being unable to meet the energy demand for several years. Presently, an increase of 12,027 MW has been evident in the current energy production capacity of 33,801 MW contrary to the capacity of 20,774 MW in 2013. On the other hand, the is a slight increase of 10,911km in the seventeen years as it was 42544 km in 2000 while the length of exiting transmission lines is 53455 km in 2017. Ironically, only a 26% increase has been done in a timespan of seventeen years in contrast to the 63% increase in the energy production capacity in the duration of five years.[101] The certainty is undermined due to the negligence in the increase and up-gradation of the transmission system as evident by the above calculations.

In contrast to the required demand of energy in Pakistan, the existing systems of transmissions and distributions are not satisfactory. The successive governments manifested skewed priorities which resulted in the failure to provide a sustained supply of energy to the customers. The estimated losses of PKR 213 billion for the last one year are also a reason for this negligence in the increase and up-gradation of transmission and distribution systems. Contrary to the NEPRA's approved line losses limit of 16.5%, the current system loss is around 17.6%. There are various obstacles being facing by NTDC such as inadequate practices for modern human resources, flaws in corporate controls, ineffective and insufficient decision-making capacities, and dependency on out-dated

[100]Hafiz Bilal Khalil, & Syed Jawad Hussain Zaidi, "Energy Crisis and Potential of Solar Energy in Pakistan", *Renewable and Sustainable Energy Reviews*, Vol. 31, (2014), pp. 194-201

[101]Farrukh Saleem, "The Power Sector", *The News*, (11 November 2018)

manual for processing of budgets further adding in the poor transmission infrastructure and delay in the advancement of transmission network for which amount of PKR 3.263 billion is needed. In this perspective, the World Bank provided a loan of USD 425 million in June 2018 for the modernization of the transmission system. According to the World Bank, the existing transmission lines are incapable to transmit the energy over 17,000 MW in contrast to the existing demand of over 20,000 MW.[102] Due to this deficiency, an estimated 3000 MW energy produced in power generation plants cannot be transmitted to its destination. The excessive loads on the transmission line often resulted in the tripping of transformers and thus causing regular and extended total blackouts. The need for advancement and modernization of existing transmission and distribution systems along with the related issues were highlighted by members of the Economic Coordination Committee (ECC) to the newly elected Prime Minister in the recent meeting of power division.[103] Whereas various other aspects also impact the certainty of transmission like the technical faults in the transmission networks, and the power theft which is associated with the affordability aspect of energy seems to be the utmost vital reason for the energy inefficiency in Pakistan.

The vulnerability of the transmission and distribution system from the terrorist attacks cannot be undermined as it is extended on thousands of miles whose protection seems impossible. The centralized energy production system is a concern where the energy is produced in a small number of energy production plants and being transmitted to various cities and regions through vastly extended transmission lines which cause stress on the transmission lines due to bulk high-voltages and thus become more acutely vulnerable to terrorist attacks as damages to few towers or transmission line could bring down the energy transmission system for cities and/or regions. In January 2015, 80% of the country plunged into darkness due to a terrorist attack on a transmission line in Naseerabad, Baluchistan. Though this attack was aimed to disrupt the 220 kVA line which was extended to Baluchistan from Guddu Power Plant but it initiated the spilling consequences through which 500kVA transmission line was tripped and resulted in shut downing

[102]"Pakistan Gets $425 Million Loan to Modernise Transmission Network", *The Express Tribune,* (14 June 2018)

[103]"Power Blackout to Continue Till Dec Due to Overload Transmission Systems", *Pakistan Today, (*31 August 2018)

Jamshoro and Bin Qasim Power Stations.[104] This transmission issue will be discussed further in chapter 3 while deliberating about the centralized vs. distributed energy governance systems.

### 3. Energy Affordability

According to the ESI index, the third level is the affordability of energy after ensuring the sufficient production of energy and its availability to the end consumers. The alignment of energy prices along with the purchasing power of the consumers is simply termed as affordability of energy. The energy insecurity prevails if the energy generated is provided to the end-users at a higher cost which is not affordable to them due to their purchasing power disparity. Following is a detailed account of scholarly researches shedding light on the affordability of energy prices.

Carol et al pointed out that the social acceptance of any technology is dependent upon its affordability. A technology will not be acceptable to the consumers if it is expensive and causing the purchasing power disparity of the customers. It is also emphasized that the desired needs must also be fulfilled along with its low cost. Thus, it is evident that the social acceptance of any energy technology is reliant upon its affordability aspect.

The certainty of energy security is not only undermined by the power theft (as discussed in the previous section) rather it has a linkage with the affordability of the energy. Bergasse, Paczynski, Dabrowski and De Wuld have developed a linkage among the income of consumers and energy costs along with the power theft issue in Pakistan while stating that several problems emerged due to the high cost of energy and bills such as weakening socio-economic conditions and poor living standards.[105]

The disparity in the affordability of energy costs which is beyond the purchasing power of the customers forces them to steal energy from the power network. Moreover, overbilling is a managerial reason for high costs of energy besides the actual high energy costs. The manual reading by WAPDA personnel projected a flaw as the units consumed

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[104] Shahzad Baloch and Irfan Ghauri, "Attack on Power Lines in Balochistan Causes Nationwide Blackout", *The Express Tribune*, (25 January 2015)

[105] Emmanuel Bergasse et al., "The Relationship Between Energy and Socio-Economic Development in the Southern and Eastern Mediterranean", *CASE Network Reports*, No. 112, (2013)

are put higher than the actual consumption both intentionally and mistakenly. Bills of hundreds of thousands are sent to the household consumers living in rural areas against the minute consumption of energy. This overbilling caused many consumers to commit suicide according to media reports. Ultimately, the higher energy costs resulted in the bypassing meter and/or disconnection of meter which force the consumer to adopt illegal means like direct connection (commonly known as Kunda system) to acquire energy.

It is also highlighted by Jamil and Ahmad on the same aspect of the ESI index by stating that power theft is a major concern in energy security as annual power theft of PKR 100 billion is happening in Pakistan according to some reports. The economic reasons especially the energy affordability of consumers is the major impediment along with the managerial issues like transmission and distribution of energy as discussed in the previous section. A reciprocal cause and effect relationship develops among the higher unaffordable bills of energy and power theft. A decrease in the income level would increase the power heft whereas the increase in the energy costs would have resulted in greater power theft. This power theft then results in an increase in the revenue losses and a hike in the energy costs has been imposed which further encouraged the theft of power from the national system.  Thus, the price of affordability has a greater significance in order to limit the negative elements of power theft. Thus, it can be concluded that though the energy crisis is a fundamentally a governance problem but it is interrelated with the pricing of energy. The unit price of energy reach at PKR 15.45 in September 2018 which classified it as the top-ranked country in the region with higher energy prices. On the other hand, per unit price in India was around USD 0.008 (PKR 9.9 according to the currency exchange rate on 24 September 2018). Therefore, an increase in energy prices is not a viable solution to this issue.[106]

The energy mix of Pakistan has a higher reliance on oil especially the imported oil. it is evident from various researches that the countries having higher dependability on the imported oil continuously experiencing their vulnerability towards the high prices of oil. The financial burden has been increased in such oil-importing countries with fluctuations in the oil prices in the international markets. Therefore, the energy security of

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[106]"Root Cause Analysis of Power Crisis in Pakistan & Its Solution", *Jigsaw Engineering Technologies,* (January 2018)

Pakistan will be continuously undermined if it constantly relies on the imported oil and ultimately destabilizing and weakening the affordability of energy.

## 4. Energy Sustainability

The aspect of sustainability is extended by the environment impact assessment as per the ESI index. As stated earlier, the concept of energy security has been evolved and matured with the passage of time. Initially, the focus of energy security was on the availability, supply, and costs of energy but progressively, definitions of energy security have incorporated the dimensions of climatic issues. Although, human life has been changed and improved with the economic growth and rapid industrial development but the vulnerabilities to the global environment are also increased due to severe climatic threats. The global earth temperatures are constantly increasing due to emissions of carbon dioxide and other greenhouse gases as a result of excessive utilization of fossil fuels, and industrial wastages. The last two decades have witnessed more of these increases.

The worldwide attention to the issue of climate change forced the world to realize that the primary reason of global warming is the GHG emissions from the industries and power generation sector. Thus, a significant global shift towards clean sources of energy from the fossil fuels has been observed. Though this shift was also triggered by various other reasons like supply constraint, depletion of fossil fuel resources, the requirement of heavy capital and infrastructure, and finite characteristic of these resources but the negative impacts on climate are most significant of all. Coal is considered as the dirtiest among all other sources of fossil fuels which has more concentrations of carbon dioxide and has GHG emissions. Therefore, there is a dire need of utilization of clean sources of energy with lowest environmental impacts and consequences. In the 21$^{st}$ century, the efforts to limit the GHG emissions have developed as the top priority agenda along with the depleting resources of fossil fuels. Moreover, the concerns regarding the supply of energy vis-à-vis energy demands are also increasing at the global level.  The overall rate of sustainability of renewable energy resources is quite high. Though there are some adversarial environmental impressions of clean renewable energy resources but these are comparatively insignificant. In a nutshell, the aspect of sustainability is the driving force which is drifting the world away towards the utilization of renewable sources of energy instead of depleting fossil fuels.

A report has been published recently by the Massachusetts Institute of Technology (MIT) which comprehensively analysed the energy sector and provided an in-depth scenario of the nuclear energy potential and its role in the future deep carbonization. The global energy mix has merely a 5% share of nuclear energy.[107] The potential contribution of nuclear energy is highly conducive to the accomplishment of the de-carbonization goals. Contrary, the deficiency or non-existence of its share in the energy mix will ultimately result in the higher costs of the required goals. A combination of low or zero-carbon modernized tools and skills are required to reduce the greenhouse gases alongside their estimated demand. However, nuclear technology can contribute an impressive role in this regard but its cost concerns exert fundamental challenges in its realization. The findings of the said report are evident of the facts that the renewable technologies specifically the solar power technologies make a stronger case in realizing the sustainable environment objective due to their constantly decreasing costs. Contrary to the efficacy of nuclear technology in the reduction of greenhouse gases, there are various disastrous environment impacts are associated with it especially the risks of nuclear accidents and the issues of handling the nuclear wastes.

Hydroelectric energy generation system is the most eco-friendly and non-polluted source of energy generation that utilizes the renewable source of water. Apart from its efficacy, some environmental impacts are also exerted by this system like the massive land acquisitions for construction of large dams destroy the ecosystem, have adverse effects on the flora and fauna of adjacent areas, massive displacement, and relocation of communities, and likewise. On the other hand, Geothermal Power Plants also have negative environmental impacts due to their contribution to the greenhouse effects and emissions of toxic gases like carbon dioxide, hydrogen sulphide, and others. In the same manner, the clean wind energy production system negatively impacts on the environment as it curtails the configurations of bird migration during migration seasons. Moreover, the visuals caused by the wind technologies are not usually admirable by the communities.

Solar technology does not involve any industrial operation in the process of energy generation as the sunlight received by solar panels is directly converted into DC

[107]David Petti, "The Future of Nuclear Energy in a Carbon-Constrained World", *MIT Energy Initiatives*, (2018)

form of energy and thus have zero emissions of carbon dioxide. Solar technology also has various other advantages like the production of low volume noise as the noise produced by the inverters of large centralized installations is barely around 10m. Sufficient data has been provided by various national and international scholarly researches in support of the sustainability of solar technology. In this regard, Haas concluded that from the environmental perspective, solar photovoltaic established as the ideal replacement of conventional sources of energy generation. It is indicated in a research by Panwar, Kaushik, and Kothari that around half of the increase in the global temperatures and various other adverse environmental effects are caused by the conventional sources of energy production like increased air pollution, acid rains, and various health issues due to their excessive utilization of fossil fuels. The climatic challenges exerted by the utilization of conventional sources of energy production can be overwhelmed through the utilization of solar technology. Therefore, the renewable energy technologies especially solar technology can substitute the conventional sources of energy generation and provide a remarkable opportunity in the reduction of global warming and mitigating the emissions of greenhouse gases.[108]

While exploring the environmental impacts of solar energy, Hernandez, R. R, et al suggested that in order to meet the objectives of reduced emissions of greenhouse gases, solar technology must be adopted as a substitute of the carbon-intensives options of energy production as this technology utilizes the sun, a renewable source of heat and electrons. He concluded that in comparison to the conventional sources of energy as well as the other renewable sources of energy, solar energy has the lowest environmental impacts. Hence, the need for utilization of solar energy has been increased with the increase in the demand for energy along with environmental and climatic changes. A research conducted in the United State of America by Pimental et al stated that the solar energy has the potential to decrease the environmental issues and meet the future energy demands of the United States in comparison to all other renewable sources of energy production.[109]

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[108]N. L. Panwar, S. C. Kaushik and Surendra Kothari, "Role of Renewable Energy Sources in Environmental Protection: A Review", Renewable and Sustainable Energy Reviews, Vol. 15, No. 3, (2011), pp. 1513-1524

[109]David Pimentel, et al., "Renewable Energy: Economic & Environmental Issues", *BioScience,* Vol. 44, No.8 (1994), pp. 536-547

In a distinctive research on Turkey, Kamil and Kaygusuz pointed out that the increased air pollution and negative environmental issues are caused by the excessive use of fossil fuels thus recommended the necessity of development and adoption of the alternative sources of energy that will contribute in the improvement of environment which further have positive impacts on healthier human life. Moreover, the amount spent on the import of expensive oil will be saved and thus contributing to the foreign exchange reserves. It is further highlighted that the governments are not only bound to take certain measures to facilitate the development of renewable energy as well as its commercialization according to Kyoto Protocol. According to Hosenuz zaman et.al, there is no industrial process or the use of fossil fuel is involved in the generation of energy through solar technology thus it is the most environment friendly and clear source of energy. Moreover, Tsoutsos, Frantzeskaki, and Gekas mentioned that the solar PV system of energy production exerts better returns to the environment and ultimately adds to the improved quality of life, better social activities, and human health.[110]

In a research conducted by Varho on the environmental impacts of solar PVs concluded that it is easy to handle the wastes of solar PVs as they are relatively easy to recycled and therefore have a lower reproduction cost.[111] It is identified by Wang, Li and Cheng stated that the adverse environmental impacts caused by the conventional sources of energy generation have been greatly mitigated by the help of solar energy. A reduction of 539,100 tons of CO2 and 432.900 tons of nitrogen has been recorded since the inception of the solar energy system in 2008 as per their research findings. The areas where people rely on wood and grass from forests for cooking and heating, especially in the winter season, the solar thermal and home technologies, are help people in these regards thus saving the forests and ultimately contributing to the prevention and sustainability of the environment.[112] This notion is also highlighted by Opens haw by indicating that the place where people are dependent upon the wood obtained from the forest for the cooking and heating purposes can be diverted to the utilization of solar energy and thus the deforestation can be reduced.

[110]Theocharis Tsoutsos, Niki Frantzeskaki, & Vassilis Gekas, "Environmental Impacts from the Solar Energy Technologies", *Energy Policy,* Vol. 33, No.3 (2005), pp. 289-296

[111]ViljaVarho, "Environmental Impact Of Photovoltaic Electricfication In Rural Areas", *Energy & Environment,* Vol. 13, No.1 (2002), pp. 81-104

[112]Limao Wang, Li Hingqiang and Cheng Shengkui, "A Study of the Ecological Effects of Solar Energy Development in Tibet", *Mountain Research and Development,* Vol. 32, No. 1 (2012), pp. 83-91

The renewable and alternative sources of energy are sustainable and viable choices to manage the existing as well as future energy crisis along with reducing the emissions of greenhouse gases but still, the worldwide contribution of these resources is around 21.8% in the overall consumed energy. Various studies piloted in various countries like Bangladesh, Ghana, Malaysia, Nepal, Nigeria, and Slovenia, established the collective agreement on the potential and sustainability of these resources and considered them as the safe options while managing the degradation of the environment. Pakistan is the most vulnerable country to the negative impacts of climate change despite the fact that it ranked at 135$^{th}$ number in the list of contributors of greenhouse gases with the share of an estimated 0.8% of total global emissions of greenhouse gases. The primary reasons behind this vulnerability to climate change are the demography, geography and varied climatic circumstances. Although, nature has blessed this country with an abundance of renewable and alternative energy resources yet there is a dire need for their utilization to accomplish the energy security along with the aspect of sustainability.[113]

In the work of Bhutto, Bazmi and Zahedi, it is claimed that the sustainability aspect of the solar technology has caused an increase in its demand. The abundance of renewable resource i.e., bio-energy, micro and macro hydel, solar and wind energy are blessings of nature upon Pakistan. The commercial and technological feasibility of these resources is also available in the country. Solar energy, in comparison to other renewable resources, is relatively a clean and sustainable source of energy.[114] The solar technology is often criticized for the excessive utilization of land in case of large installations which ultimately cause concerns about the food security thus its sustainability is often questioned. This concern can be waived off by the utilization of barren lands for the installations of solar PVs having no agricultural concerns and biodiversity as the Sahara Desert which provides an ideal location for large centralized solar PV installations.in Pakistan, the large barren lands of Baluchistan and the large area of Thar Desert are ideal locations for the large centralized solar PV installations. There are around four million acres of cultivable wasteland and uncultivable area including forests is around 514617

[113]Afifa and Qurat-ul-Ain, "Climate Change: Implication for Pakistan and Way Forward", *ISSRA Papers,* (2017)

[114]Abdul Waheed Bhotto, Aqeel Ahmed Bazmi, & Gholamreza Zahedi, "Greener Energy: Issues and Challenges for Pakistan-Wind Power Perspective", *Renewable and Sustainable Energy Reviews*, Vol. 20, (2013), p. 519

acres in Pakistan as per Agricultural Census 2010 whereas the Quaid-i-Azam Solar Park covers an area of 500 acres only with an energy generation capacity of 100 MW.

The non-renewable sources of energy especially the fossil fuels are being constantly utilized at a faster pace in the last four decades due to the economic development and growing industrialization. Regardless of the introduction of new technological developments that enhanced the energy efficiency, "world energy consumption increased by about 16% between 1990 and 2001, to reach 403.9 quadrillion ($10^{15}$) BTU (British Thermal Unit) in the last year [2004]."[115] This growth is primarily nourished by the fossil fuels as coal, oil, and natural gas altogether during the year 2015 which yet made up "over 80 per cent of all energy consumption, much as they did in 1985." The measuring levels of depleting energy resources are cautioning about the exhaustion of the existing reserves of the resources and thus the progress on the developments and discoveries of new resources becomes inevitable. There is a dire need of ensuring certain actions for the measurement of existing resources along with the extent to limit their depletion and discoveries of new resource reserves. The depletion of fossil fuel reserves and climate issues become the most important international issues which are closely associated with the energy security.

The utilization of oil products usually made by crude oil along with petroleum liquids that are produced from coal and natural gas has increased that is responsible for 45% of global energy consumed in the year 2000 which were around 22% in 1940. The use of alternative means of energy generation and depleting fossil fuel deposits forced many experts of the energy to believe that in the first quarter of the 21st century, its supply will reach at the higher level but will start to decline somehow between now and 2025. That is the reason that the energy generation in developed countries has the least dependent upon the fossil fuel products.

The significance of fossil fuel products in the energy production at the global level cannot be underestimated but the rising prices of fuel-oil in the international markets declined its share from 25% in 1970s to 6.6% during 2005. Contrary, despite minor reserves of 371 million barrels, the share of oil in the overall energy generation mix of

[115]Linotte Daniel & Reuchlin Philip, "Addressing Global Energy &Security Challenges", *Central Asia & The Caucasus*, Vol. 3, No. 33, (2005), p. 90

Pakistan is constantly increasing as its share in the year 2008 was 32.2% which jumped to 37.8% during 2010. The existing oil reserves of Pakistan are insufficient to meet the existing demands thus it heavily relies on the imported fuels and thus become vulnerable to the increasing import bills, fluctuations, pressures, and uncertainties of the international oil market. The recoverable crude oil reserves balance of Pakistan was 350.632 million barrels as of June 30, 2016, which declined from 384.407 million barrels the previous year, however, the production was recorded as 31.65 million barrels during the fiscal year 2015-16, against 34.49 million barrels the previous year. The annual oil refining volume of Pakistan was 19.79 million tons/year whereas 12.13 million tons of crude oil was processed in the oil refineries of Pakistan. During the fiscal year of 2015-16, the overall import of crude oil has witnessed an increase to 8.68 million tons contrary to 8.33 tons imported during the fiscal year 2014-15. Luckily, the sharp drop in the prices of crude oil in the international oil market has reduced the cost from USD $4.58144 billion to USD $2.75327 billion. Ironically, Pakistan has suffered an annual loss of PKR four billion as the direct loss of its valuable foreign currency due to the decreasing value of Pakistan rupee by PKR 1 vis-à-vis value of USD.[116]

The energy generation ix of Pakistan has witnessed a sharp increase in the share of gas as the primary source of energy supply in the country along with an increase in the production capacity. The total energy generation capacity during the fiscal year 2014-15 was 70.36 mtoe which was increased to 73.97 mtoe at a rate of 5.27% in the following year. The total share of natural gas was at the maximum with 30.46 mtoe during the fiscal year 20116-16. Natural gas's recoverable balance reserve in Pakistan reduced to 20.26 trillion tcf to 19.16 trillion tcf as its utilization in the energy sector increased from 371562 million tcf to 440593 million tcf during the same year.

On June 30, 2016, the projected coal reserves of Pakistan persisted the same at around 186 billion tons as per the previous year whereas a slight increase from 3.72 million tons to 4.14 million tons has been recorded in its production during the same year. On the other hand, a decrease in the import has been witnessed from five million tons to 4.88 million tons during the same year costing PKR 47415 million and in the same period, its utilization in the energy generation sector has increased from 151180 tons to 204432

[116] National Electric Power Regulatory Authority (NEPRA), "State of Industry Report 2017", (Islamabad: NEPRA, 2017)

tons. The production of energy through the utilization of coal was 102 GWh for the period of the fiscal year 2014-15 and 148 GWh for the year 2015-16.

It is evident that the energy production in Pakistan is generally reliant upon the fast-depleting fossil fuels whose reserves are being diminished nationally and internationally. The whole world especially the developing world is anxiously working on the utilization of alternative and renewable energy resources due to the concerns over the depleting reserves of fossil fuels. Ohunakin et al while exploring solar energy potential in Nigeria stated that despite the abundant resources of fossil fuels like oil, gas, and coal, there is a dire need of exploitation of the renewable sources of energy because the over reliance upon the fossil fuels for generation of energy can increase the pace of their depletion before the expected time.[117] The increased dependency upon the use of gas and oil for energy generation is not only adversely impacting the foreign exchange reserves of Pakistan but also causes a reduction in the estimated period of complete depletion of its oil and gas reserves. In the perspective of depletion of conventional energy resources, it is essential to exploit the enormous potential of renewable energy resources i.e. hydel, solar and wind. However, this shift in the selection of energy choices will not only limit the pace of depletion of conventional energy resources but also reduce various impacts of climate change through positive contributions to the environment.

The definition of ESI indicator of natural catastrophe is 'frequency and intensity of occurrence of natural catastrophes influencing the energy's demand and supply'. In response, the reliability of consumption of energy sources in the aftermath of a natural calamity. Natural disasters not only affect the physical infrastructure of the energy production system by inflicting damages to the capacity elements, transmission and distribution capabilities etc but also impact the demand, supply, and affordability trends of energy. Therefore, the most significant indicators of natural catastrophe are the impacts of climate change on energy systems. Thus, the adaptability to the existing trends of climate change is essential for the reliability of all energy sources.

The reliability of hydro power is compromised due to the unavailability of water or variations in its availability. The production of hydro power may also be impacted by the

[117]S. Olayinka Ohunakin, et al., "Analysis of Cost Estimation & Wind Energy Evaluation using WECS in Nigeria", *Energy Policy*, Vol. 48, (2012), pp. 594-600

high level of rains containing sediments and leading to floods. The energy infrastructure of hydro power, as well as oil and gas-based generation systems, are damaged due to heavy rainfalls. On the other hand, heavy cooling water is required for cooling systems of nuclear power plants while in extremely hot weather conditions high temperature water can also reduce efficiency level. The transmission and distribution system are also damaged by higher rates of floods and rainstorms. The sensitivity of energy generation, transmission and distribution, and energy demand to weather conditions, climate variability are illustrated by nature through the states.[118]

These effects and changes are mostly gradual as well as important. Usually, the natural disasters have mostly disruptive impacts and thus there must be the inherent mechanisms in power systems for the absorption of the continued and sustained shocks while the lack of these mechanisms could result in prolonged and severe disruption of energy. Pakistan has suffered prominent disasters in the form of earthquakes, floods, and windstorms. Varying severity of floods has become a frequent phenomenon while devastating earthquakes have been few vis-à-vis floods and windstorms.

The report ‘A Science for Policy; by the Joint Research Centre (JRC), the European Commission’s Science and Knowledge Service, identified that Earthquakes have the potential to severely cause damages to the power generation, transmission, and distribution structures. Strong seismic motions can cause buildings, housing, and control rooms, heavy machinery, and equipment to get seriously damaged, collapse, or being destroyed. Though, equipment within the buildings, e.g., computers, network racks, electrical panels, HVAC equipment, and batteries racks are more vulnerable to collapse due to strong shocks and the subsequent horizontal loading. Similarly, power transformers are also vulnerable to both inertial seismic loading as well as falling down due to severe shaking. The switchyard also undergoes extensive damage due to seismic cable tension and/or excitation and/or rocking of nearby equipment. Transmission towers usually collapse or permanently drift and deformation of tower members/legs occur in the transmission and distribution system during an earthquake whereas the considerably long

[118]Pierre Audinet, Jean-Christophe Amado and Ben Rabb, “Climate Risk Governance Approaches in the Energy Sector: Lesson from Early Adapters”, *Weather Matters for Energy*, (New York: Springer, 2014), pp.17-64

period time of time is required in replacing a tower. During the 2005 earthquake, Pakistan suffered all of the aforementioned losses, and it took months to fully recover the system.

Pakistan is also a victim of a frequent disaster and varying severity of floods. The province of Khyber Pakhtunkhwa along with parts of Sindh and Punjab were severely affected by the floods of 2010. These floods caused severe damages to the energy infrastructure including the explosion of transformers, burning of switchboards, and weakened foundation of the transmission towers, along with other reported damages in the above-cited report of the Joint Research Centre. Moreover, the floods also negatively impacted the thermal energy generation plants by disrupting the supply of oil and gas.

An effective early warning and response mechanism to diminish the impacts of such disasters is lacking in Pakistan. The earthquake emanated as a shock and caused enormous damage to the power sector and disrupted 100% power supply in the affected areas besides the immense human loss. Luckily, the epicentre of the quake was away from the main energy-producing power plants. Yet, it took significant efforts and time to recover the damaged transmission and distribution infrastructure and restore power supply. Despite receiving the early warnings of the 2010 floods, the enormity of the disaster came as a rude shock, destroying the power sector as much as it did in other sectors like agriculture, etc. There is a dire need to enhance the resilience of our electric power structures through enhancing response efficiency through building strong logistics, redundancy, interconnections, and with a perspective to mitigate the damaging impact of such disasters on the power sector.

## III Energy Crisis

In the light of Kai Erickson's explanation of significant events which are 'too singular and much special to fit in a general frame', Energy crisis can be labelled so as energy crisis is believed to be a social process associated with the political and technological issues. American President Mr Jimmy Carter has brought the issue of energy crisis into focus by highlighting the gravity of energy situation and called it 'unprecedented in our history' while addressing to the American citizens and Congress on

18 and 20 April 1977 respectively.[119] The alarming increase in the US demand for oil, its escalating prices, and the instability in the global economy which provoked the demand for oil caused the energy crisis of 1970s. Energy crisis is the shortages in the continuous supply of the energy resources as Brown considered it as the 'issue of increasing prices of oil and decreasing production of oil." This notion is evident that how the scarce energy resources are impacting the developed as well as the developing countries to power their economies. Energy crisis is the modification in the balance of energy resources with associated environmental and economic effects that are caused by the changes in the demand patterns. Mbalisi Onyeka Festus & Offor Beatrice Ogoegbunam considered energy crisis as the conflict of interest among the owners of energy resources and the owners of technologies utilized for the energy resources' exploration, exploitation and transformation.[120] In the recent years, energy crisis has emerged as a comparatively common and enduring issue for the developed and developing countries for which development of security architecture essential for coordinated and long term governance of the issue.

The primary condition for the economic development, prosperity, and quality life style of people is the availability of energy whereas the shortages of the energy supply are becoming a global alarming issue. The demand and supply of energy to the economy is directly proportional to the growth and prosperity of that economy. The substantial variation in the supply of energy resources vis-à-vis the demand of an economy, energy crisis is produced. The case of energy crisis of Pakistan is presented owing to accumulative shortage of energy (See Table 1.3). Energy is the vital component of the national security due to the limited reserves particularly the fossil fuel resources including coal, gas, and oil. In order to compete in the global world, the availability, affordability, sufficiency, reliability, and sustainability of the energy resources built strong economic base for a country. Apart from the shortfall in the availability of energy supplies, energy crisis is also associated with the higher cost of energy resources. The rise in the annual global energy demand in the next two decades is expected to be around 1.7% due to increased economic growth in the global economy thus generating the fears of the emergence of the final energy crisis in the world. The depleting reserves of fossil fuels

[119]Albert A. Bartlett, "Forgotten Fundamentals of the Energy Crisis", *American Journal of Physics*, Vol. 46, No. 9, (1978), pp. 876-888

[120]Mbalisi Onyeka Festus, & Offor Beatrice Ogoegbunam, "Energy Crisis and its Effects on National Development", *British Journal of Education*, Vol. 3, No. 1, (2015), pp. 21-37

impacts the sufficient generation of energy, triggering the energy prices, and causing a growing gap between the demand and supply of energy. In this regard, the shift towards the utilization of alternative means of energy resources becomes inevitable to manage and sustain the continued supply of energy through an effective and sustainable structure of energy production and its supply.[121]

**Table 1.3 Magnitude of Demand and Supply Gap**

| Year | Demand and Supply Gap |
|---|---|
| 2011 | 7,000MW |
| 2012 | 6,000MW |
| 2013 | 5,000MW |
| 2014 | 7,000MW |
| 2015 | 6,000MW |
| 2016 | 4,000MW |
| 2017 | 7,000MW |
| 2018 | 7,000MW |

**Source:** Kamal A. Munir and Salman Khalid, "Pakistan's Power Crisis: How Did We Get Here?", *The Lahore Journal of Economics,* Vol. 17, (September 2012), p. 73

Economic security of a country is dependent on the energy security as the energy is essential for economic activity. In the case of developing countries, the energy plays a vital role in the growth of economy as the determinant of development. Energy Security has emerged as the main component of national security of the modern globalized world which revolves around the affordable, sufficient, reliable and sustainable availability of energy resources to the economy.[122] Therefore, the concept of energy security is much broad and complex in nature. It is an issue which regardless of continuous efforts is on-going and becoming worse with the passage of time. The cause behind this worsening of the energy crisis is the inability to understand and address the multifaceted reasons and their solutions along with the continued effective efforts for resolving this issue.

According to various estimates, the South Asian developing countries will account for the biggest share in the rising demand for energy globally. Unfortunately, in case of Pakistan, the notion of 'Energy Security' has long been neglected for decades and thus

[121]Jörg Schindler, & Werner Zittel, "Alternative World Energy Outlook 2006", *Advance Solar Energy,* Vol. 17, (2015), pp.1-44

[122]Sharon Burke, "Natural Security", *Centre for a New American Security,* (2009)

resulted in the atrocious consequences of energy crisis causing power cuts and acute deficiencies in the availability of energy supplies. The roots of the existing energy crisis in Pakistan can be traced to the structural inadequacies prevailing in the energy policies. Moreover, the lack of cohesion and effective cooperation between the ministries and departments responsible for the production, governance and distribution of energy is also a key factor in the growing energy crisis in Pakistan. The energy crisis has undeniable implications on the Pakistan's economy as it cuts the progress of GDP by more than 2% annually.[123] The persistent and severe energy crisis has entangled Pakistan which is not only affecting its economic cycle but also impacting the quality of life of an average citizen. Thus, the energy crisis situation is negatively impacting the energy security efforts in Pakistan.

China Pakistan Economic Corridor (CPEC), being an essential part of One Belt and One Road (OBOR) project, is an initiative of Chinese President Xi Jinping proposed in the year 2013 and signed lately in 2015 which brought investment of $62 billion in Pakistan for reviving and deepening strategic cooperation along with economic growth through infrastructure development, industrial zones, and development of energy sector. The energy sector in Pakistan persisted ineffective since its independence due to the economic, organizational incompetency, technological backwardness, and political issues which caused the deterioration of this sector. The most vital aspect of CPEC is the investment of $34 billion in the energy sector related projects to overcome the existing energy crisis in Pakistan. The 'Early Harvest' fast tracked plans are designed to construct the energy generation projects between the years 2015 to 2018 which can help in the achievement of energy security. The focus of energy production under CPEC revolves around the utilization of four conventional and renewable technologies mainly coal, hydro power, solar and wind energy with a percentage share of 69%, 21%, 7%, and 3% respectively. Thus, the share of energy generation mix of the country will be more inclined towards the utilization of coal instead of oil.[124] A detailed account of energy projects under the CPEC is presented in the table 1.4.

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[123]Elizabeth Mills, "Pakistan's Energy Crisis", *Journal of Peace Works,* Vol. 79, No. 4, (June 2012), p. 7

[124]Hasan Raza, "CPEC: The Counter Balancer of Momentous Energy Crisis in Pakistan", *Advances in Social Sciences Research Journal*, Vol. 5, No. 7, (2018)

**Table 1.4: Energy Projects in CPEC**

| S. No | Project Name | Mega Watt (MW) | Estimated Cost (US$ M) |
|---|---|---|---|
| 1 | Port Qasim Electric Company Coal Fired, 2x660, Sindh | 1320 | 1980 |
| 2 | Sahiwal 2x660MW Coal-fired Power Plant, Sahiwal, Punjab | 1320 | 1600 |
| 3 | Engro Thar 4x330MW Coal-fired, Thar, Sindh | 1320 | 2000 |
| 3A | Surface mine in Block II of Thar Coal field, 6.5 metric ton per annum (mtpa), Thar, Sindh | | 1470 |
| 4 | Gwadar Coal /LNG / Oil Power Project, Gwadar | 300 | 600 |
| 5 | HUBCO coal power plant 1X660 MW, Hub Balochistan | 660 | 970 |
| 6 | Rahimyar Khan Coal Power Project, Punjab | 1320 | 1600 |
| 7 | SSRL Thar Coal Block 1 -6.5 metric ton per annum(mpta) Thar, Sindh | | 1300 |
| 7A | SSRL 2×660 MW Mine Mouth Power Plant, Sindh | 1320 | 2000 |
| 8 | Zonergy 900MW Solar Park, Bahawalpur, Punjab | 900 | 1215 |
| 9 | Dawood 50MW Wind Farm, Bhambore, Sindh | 50 | 125 |
| 10 | UEP 100MW wind Farm, Jhimpir, Sindh | 100 | 250 |
| 11 | Sachal 50MW Wind Farm, Jhimpir, Sindh | 50 | 134 |
| 12 | Suki Kinari Hydro power Station, KPK | 870 | 1802 |
| 13 | Karot Hydropower Station, AJK & Punjab | 720 | 1420 |
| 14 | Matiari to Lahore Transmission line | | 1500 |
| 15 | Matiari to Faisalabad Transmission line | | 1500 |
| 16 | Gaddani Power Park Project (2×660MW) | 1320 | 3960 |
| 16A | Gaddani Power Park Project (Jetty + Infrastructure) | | 1200 |
| 17 | HUBCO Coal Power Plant 1X660 MW, Hub, Balochistan | 660 | 970 |
| 18 | Kohala Hydel Project, AJK | 1100 | 2397 |
| 19 | Pakistan Wind Farm II 2X50 MW (Jhampir, Thatta, Sindh) | 100 | 150 |
| 20 | Thar mine mouth oracle, Thar Sindh | 1320 | 1300 |
| 21 | Muzaffargarh Coal Power Project, Punjab | 1320 | 1600 |
| | | **16070 MW** | **33043 Million** |

**Source**: China-Pakistan Economic Corridor Available At: http://cpec.gov.pk/

The rapid increase in the impacts of climate change and the rising global temperatures are issues of grave concern for the global community. The GHG emissions are recorded at the highest level in the history due to the increased global anthropogenic increase of humans which contributed in the contamination of the environment and global climate. Currently, Pakistan is at a crucial phase in its commitments for limiting and combating the emissions of GHS. The carbon emissions within the national GHS emissions lonely accounts for 87% according to statistics while on the other hand, the energy sector is the highest GHG contributor due to its reliance on fossil fuels mainly oil and coal according to the statistics presented by Economic Survey of Pakistan.[125] Ironically, the energy projects under CPEC have a major share of coal which are relying upon the imported coal rather utilizing the existing coal reserves within Pakistan thus the cost of energy produced through these coal energy generation projects is high impacting the affordability, sufficiency, reliability, and sustainability of the energy.

The above discussion on significance of energy for human life in past as well as in present, and its historical perspective in terms of security along with its extended spectrum on national security has been provided. The application of Energy Security Index (ESI) through four defined indicators has also been carried out for a better understanding of security situation in Pakistan. It has covered security aspects of dependency including availability and utilization of energy resources; its supply through transmission network; its affordable costs; sustainability as per environment impact assessment; depleting energy resources along with discovery and development of new resources; and reliability in resilience to the natural disasters. The energy crisis has indicated that Pakistan is not doing well in terms of energy security. Considering the past experience and future challenges of climate change, coordinated and efficient energy governance can ensure the governance of energy crisis. An increased dependency upon the alternative and renewable sources of energy particularly solar energy and generally in the form of a distributed energy generation system can address most of the shortcomings in this regard.

The theoretical framework of the study is presented in Chapter 2 in order to have understanding perspective about the energy crisis of Pakistan. Chapter 2 will premise the Theoretical Framework: Theory of Institutions and Energy Governance of Pakistan.

[125]Pakistan Statistical Yearbook, (2012)

Institutions Originate Governance: by aligning the expectations and actions of governing and the governed, developing coordination among institutions, and setting for mutual benefit among society. The chapter describes the role of informal and formal institutions in energy governance of Pakistan.

# Chapter 2

# Theoretical Framework: Theory of Institutions and Energy Governance of Pakistan

## I. Theory of Institutions

### Institutions Originate Governance

By Aligning the Expectations and Actions

By Developing Coordination

By Setting for Mutual Benefit

## II. Informal Institutions

## III. Formal Institutions

## IV. Informal and Formal Perspectives of Energy Governance of Pakistan

# Chapter 2

## Theoretical Framework: Theory of Institutions and Energy Governance of Pakistan

Institutional theory is about the structure and performance of the institutions referred economic activity or change. Informal and formal institutions broadly encourage governments, private organizations, social norms and laws to contribute to the development of rules and contracts enforcement to facilitate transactions for economic activity. Individuals working in institutions interpret world around them according to their mental caliber. Individuals choose within their mental models. Institutions provide order and structure by aligning the expectations and actions of individuals. Institutions help in developing coordination between diverse actors of society. Institutions provide governance and are designed to reduce conflicts and set basis for mutual benefits. Moreover, institutions help in reducing uncertainty within a society and, through structured rules and regulations, they are helpful in increasing economic gains. North's Theory of Institutions is applied in this chapter through following questions:

a. What kind of correlation exists between informal and formal institutions and energy crisis of Pakistan?
b. What is the role of the informal institutions that pervasively influence the energy security of Pakistan?
c. What is the role of the formal institutions that apparently influence the energy security of Pakistan?

Douglas C. North in his book, "Institutions, Institutional Change and Economic Performance", discusses that in a society institution cater economic and political framework that promote decision making and successful economic changes. The major aim of the institution is to reduce uncertainty by developing a stable and efficient structure for economic interaction. Institutions are evolved through different conventions, legal procedures, contracts between individuals, norms of the statue and common laws. Institutions, with a defined

structure of economy, increase feasibility and profitability during economic activity.[126] North argues that institutions are established to control the obstacles defined as transaction costs and institutions structure the transaction costs of exchange. Institutions influence the cost of transaction which includes the cost of designing, negotiating and enforcement of business contract. When laws are poorly defined and enforced, the value of risk will be high and prospects of economic growth will be reduced. North's model of institutional framework focuses that the uncertainty in human exchange is always alleviated by forging competent institutions. Problems emerging from imperfect and asymmetric information can be reduced by developing institutions. In this connection, the book published in 1994, is useful to cover theoretical dimension of the dissertation.

The institutions reduce uncertainty that raises confidence to accomplish the business contract. Institutions, with a definite structure, increase feasibility and profitability during an economic activity. In Douglas North institutional approach, institutional theory originated from two combined theories, first is the theory of human behavior and second is the theory of transaction cost. The source of divergent ideologies is experience of people in institutions that may lead them to develop different views about their surroundings referred economic decisions and actions. The institutions also spell their rules into multiple organizations for economic projects. Institutions offer a reliable and structural way of communication with incremental changes. In best institutional frameworks, changes occur due to modification in the mindset of economic and political entrepreneurs. Better knowledge, factual data and variability of valuable attributes provides the way for maximum dependence on institutions for a structured and cost-effective economic activity. Institutional change through the alternation in the formal rules of game is the best way of increasing return features of an institutional framework. Human beings impose constraints on interaction to structural exchanges.

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[126]Douglas C. North, *Institutions, Institutional Change and Economic Performance*, (New York: Cambridge University Press, 1990), p. 6

The specialized interdependence occurs between the institutions because of specialized interest. Institutional and technological interactions define transaction costs that are summed up to proclaim production cost. Chapter 5 assesses the CPEC projects following the energy security index. This study identifies the two dynamics of energy governance of Pakistan one is formal institutions (See figure 2.2) and the other political parties and their manifestos as informal institutions. The institutional and technological interactions are defined in perspective of China Pakistan Economic Corridor (CPEC) signed in 2015.

## I. Theory of Institutions

**Douglas C. North emphasizes the performance of institutions in the development process.**

His thought, regarding economic history and development, shapes the arguments of intellectuals across the social sciences and it leaves a good impact on public policy.[127] Douglas North, an American economist, was born in 1920 and died in 2015. He was famous for his work in economic history. In 1993, as an economic historian, he won Nobel Memorial Prize in Economics. In his renowned work, he explained economic and institutional changes, applying economic theory and qualitative methods. The work of North has major impact on recent developmental thinking. Economists highly appreciate his work. He is influential among political scientists, sociologists and historians.[128] His work is purely theoretical, methodological and descriptive. Mostly, during his academic career, the focus of his work was on the importance of human institutions. He also focused on how these institution effect economic performance and development.

**A reliable economic institutional framework is important as it serves as a pre-condition for permanent development and efficient economic performance.**

[127] Margaret Levi and Barry Weingast, "Douglas North was A Visionary", *The Washington Post*, (9 December 2015)

[128] Julio Faundez, "Douglass North's Theory of Institutions: Lessons for Law and Development", *Hague Journal on the Rule of Law*, Vol. 8, No. 2, (July 2016), p. 374

Theory of institutions and institutionalism are synonymous referred D. North an economic historian. In the history of nations, important events shape institutions which in turn determine economic preferences of the nations. A nation endowed with poor structure of institutions acts in a poor way. There are three characteristics of institutions. First, in institution, a number of people is working. Second, in an institution, there are set rules regarding the repetition of activities, constancy and the order of predictability. Third, in institutions there are folk views.[129] Institutions can be defined as individual actions controlling collective actions. Institutions practically determine human actions. In a society, institutions are designed to define preferences and powers. Institutions deliver common meanings and cognitive frames which define behaviors. They are established to shape preferences and set basis for human choice. It is very difficult to change institutions because institutional changes disturb the system.[130] In a broader sense, economic institutions involve two types of institutions. One is formal institution and the second is informal institution. Formal institutions include law, organizations and economic agents. While, informal institutions involve social customs and behavioral rules etc. A reliable economic institutional framework is important as it serves as a pre-condition for permanent development and efficient economic performance.[131] Institutions are rules that govern human interactions. In the beginning of theoretical framework, it is necessary to define three concepts as follows:

**Informal Institutions:** Informal institutions are a set of social norms, moral values, conventions, traditions and religious beliefs. It also includes behavioral norms which evolve through history. These norms determine the behavior of individuals and organizations in achieving their aims. These institutions can be called Old Ethos or The Carriers of History. These institutions evolve with the evolution of community and culture. Moreover, with the passage of time, these rules are self-enforced with mechanisms like: traditions, imitations and other ways of teaching.[132]

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[129]Walter C. Neale, "Institutions", *Journal of Economic Issues*, Vol. 21, No. 3, (1987), p. 1182

[130]Daniel Friel, "Understanding Institutions: Different Paradigms, Different Conclusions", *Revista De Asministracao*, Vol. 52, (2017), p. 212

[131]Pasquale Tridico, "Institutional Change and Economic Performance in Transaction Economics: The Case of Poland", *Sussex European Institute*, (2004), p. 4

[132]Ibid., pp. 5-6

**Formal Institutions:** Generally, formal institutions or formal rules are defined as the sphere of law which is based on constitutions, regulations and organizations. There is a direct relationship between formal rules and structure of political economy like: governance, judicial system and property rights.

**Transaction Costs:** Transaction costs involve the costs of bargain, exchange, transfer of property, start of an activity, protection of business, collection of information and the cost required to change or maintain actual institutional framework etcetera. In Transaction costs, not only financial resources are involved but time and all resources required to achieve goals are also involved. They involve public or private resources.

## II. Informal Perspectives of Institutions

"Informal institutions are socially shared rules, usually unwritten, that are created, communicated, and enforced outside of officially sanctioned channels. Informal institutions are equally known but not laid down in writing and they tend to be more persistent than formal rules.[133] "Informal institutions are (the usually unwritten) social norms, customs or traditions that shape thought and behavior".[134] This study focuses informal political institutions such as political parties because sometimes they operate within formal structure or sometimes in defiance of it. Further their rules are not binding as the state law.

Theory of institutions is quite relative to ideological characteristics of the people; because it is difficult to measure performance and behavior of the people apart from their strong beliefs regarding the impartiality and fairness of agreement.

Therefore, it is essential to understand the regard of people towards impartiality of institutional contracts. The discussion starts by knowing that ideology is ever-present and people need to rationalize the world in its surrounding. Ideology is a device to deal with different problems of life. Moreover, ideology also involves judgment regarding the

[133]Douglas C. North, *Institutions, Institutional Change and Economic Performance,* op.cit., p. 6

[134]Leftwich, A. & Sen, K, *Beyond Institutions: Institutions and Organizations in the Politics and Economics of Poverty Reduction - Thematic Synthesis of Research Evidence,* DFID-funded Research Programme Consortium on Improving Institutions for Pro-Poor Growth (IPPG), (2010)

impartiality or authenticity of contractual or institutional agreements in which humans live and work accordingly. The experiences of people provide the basis of ideologies. If all people have same experiences, their perspective about the world would be same. Common ideologies exist in tribal societies where members go through same experience. There, people have common set of philosophies, myth and taboos. These are the sources of their views and perceptions. The source of divergent ideologies is another experience of people that may lead them to develop different views about their surroundings.

The implications of ideological consensus or diversity of ideologies upon institutional modeling is clear. If, people in a society have same ideological perceptions, the formal rules that explain constrains in building up institutions will not have to be clearly defined. Moreover, the mechanism of process and enforcement may be minimum or even zero. On the other hand, societies with diverse ideological views reflect the specialized growth and labor division. They require more resources to clearly define the rules, with enforcement mechanisms. Due to conflicting ideologies, such definition along with its enforcement is required. For, an individual participant will feel no need to constrain individual maximization on the expense of other party. In given expensive gaging performance, ideological beliefs or disaffection is an important effect upon institution.[135]

Institutions and Organizations: To study institutions and institutional changes, it is necessary to differentiate between the concepts of institution and organization. Institutions are the rules of game and organizations are players. The interactions between them form institutional changes. Institutions, along with standard constrains of economic theory, define different opportunities in a society. Organizations take benefits from opportunities and benefitted organizations cause the changes in these institutions. Institutions consist of certain formal and informal rules while organizations are mainly based upon a group of individuals with some common purposes. In an institutional matrix, given opportunities define the

[135]Douglas C. North, op.cit., pp. 9-10

existence of various forms of organizations. Organizational entrepreneurs encourage institutional changes with fresh and variegated opportunities.[136]

To process the information, human beings have insufficient information and limited mental approach. As a result, human beings impose constrains on interaction to structure exchanges. There is no implication that consequent institutions will be efficient. In such a world, markets are imperfect, for major role is played by ideas and ideologies in making choices and costs of transaction. Individuals interpret world around them according to their mental caliber. Individuals choose within their mental models. Institutions broadly encourage governments, private organizations, social norms and laws to contribute to the development of formal rules and contracts enforcement to facilitate transactions. Oliver E. Williamson proposes hierarchical classifications of institutions as:

1. Level one institutions are located in the social structure of society, like: social norms, customs and traditions.
2. Level two institutions include those which are related to the rules of game with the purpose of defining and enforcement of property rights. Mostly these are formal institutions.
3. Level three includes institutions related to governance. Building governance structure, these institutions create incentives. They help in creating organizations like state agencies, local or national government, NGOs.
4. In the final level, institutions define the extent of adjustment which occurs through prices or quantities. Moreover, these institutions specify the mechanism of resource allocation.[137]

North gave four basic contributions to social sciences; neo-classical understanding of institutions, neo-classical theory of state/government, importance of economic theory and qualitative analysis in history. Regarding the role of institutions, this neo-institutional

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[136]William A. Barnett, Melvin J. Hinich and Norman J. Schofield, *Political Economy: Institutions, Competition and Representation: Proceedings of the Seventh International Symposium in Economic Theory and Econometrics*, (New York: Cambridge University Press, 1993), pp.62-63, John Harriss, Janet Hunter and Colin M. Lewis, *The New Institutional Economics and Third World Development*, (New York: Routledge Taylor and Francis Group, 1995), pp.22-23

[137]O. E. Williamson, “The New Institutional Economics: Taking Stock, Looking Ahead”, *The Journal of Economics Literature,* Vol. 38, No.3, (2000), pp. 595-613

approach has played a vital role to attract different scholars. In society, institutions provide order and structure by aligning the expectations and actions of individuals. Institutions help in developing coordination between diverse actors of society. Institutions provide governance and are designed to reduce conflicts and set basis for mutual benefits. Moreover, institutions help in reducing uncertainty within a society and, through structured rules and regulations, they are helpful in increasing economic gains.

North's model of the ideal institutional framework is derived from his extensive research in economic history. This framework enables markets to operate efficiently over time. The time dimension is crucial since, as an economic historian, North was aware that, in order properly to evaluate institutions, it is essential to take into account their durability over time. An efficient institutional framework readily adapts to changing circumstances. Such a framework provides economic and political entrepreneurs with incentives that encourage decentralized decision-making, enabling society to maximize opportunities for resolving social problems and promoting successful economic change. Adaptively efficient institutions are thus a necessary condition for achieving successful economic change. Yet, the disparity between levels of economic growth between rich Western countries and poor countries in the rest of the world suggests that very few countries have managed to achieve efficient institutional frameworks. Why is this so? North's theory of institutions attempts to answer this question and offers a conceptual framework to explain economic growth and institutional development.

The work of North accomplishes certain challenging questions:

a. What is the role of informal institutions that pervasively influences the long character of economies?
b. What kind of correlation exists between informal and formal institutions?

These questions open up the possibilities to understand the role of institutions to process in economic changes.

## III. Formal Perspectives of Institutions

"Formal Institutions include the written constitution, laws, policies, rights and regulations enforced by official authorities".[138]

According to North, institutions are developed through different stages. In the beginning, the signs of exchange emerged at village or small-scale level. It emerged in the form of small level village trade inside dense social network of informal constrains. At that time, the cost of transaction was very low. Nonetheless, with the passage of time, trade gradually went outside the village-level which increased the chances of conflict over business. When, with transaction cost, trade market expanded, the dense social network expanded. This, in response, demanded more resources for measurement and enforcement.

With the passage of time, trade picked up caravans and voyages. Though, a couple of problems emerged with the growth of long-distance trade. First, a relative was sent with the responsibility of negotiating sale and obtaining a return cargo. Second problem evolved in negotiation of a contract based on standardized measurement units and merchant law courts etc. Toll was paid to a foreign prince for safe enforcement of contract and protection of goods.

Lastly, in modern Western societies, such institutions emerged which defined a choice set to determine the cost of transaction. This engaged them in an economic activity which ensured a specialized system of transactional costs. For an efficient growth of capital market, international specialization and labor divisions need institutions and organizations to protect their properties within their national boundaries.[139]

Economists and political thinkers provide various definitions to explain the concept of institutions. According to North's pioneering analysis, in a society, institutions define the rules of game or more formally institutions are humanly devised constrains that shape human interaction. North states, "Institutions are the rules of the game in a society or more formally

[138]Douglass C. North, op.cit

[139]Douglass C. North, "Institutions", *The Journal of Economic Perspective*, Vol. 5, No. 1, (Winter 1991), pp. 99-101

are the humanly devised constrains that shape human interaction." The world is not just an open market, there are many other environmental factors in which one human interacts with another. These factors influence economic activity and performance of an economy. Institutional changes define historical evolution of societies. Therefore, institutional change is a key for understanding historical evolution of societies. An institution helps in structuring human interaction which means institutions provide incentives and disincentives to people for behaving in certain manners. If institutions are active, they shape and give incentives and also structure political, economic and social activities. Institutions work in a frictional world where there is uncertainty. In a society, institutions exist to reduce uncertainty by establishing structures for human interaction. In regular dealing with each other, institutions make predictions. Institutions not only help reduce uncertainty but allow business by solving problems in efficient and structured way. Institutions are devised with formal rules and their enforcement constrains. Formal rules are simple and clear-cut. They consist of constitutions, laws and legal procedures. They have special feature of being specific and precise. In everyday behavior and actions, formal rules occupy little portion while norms occupy vital place. So, institutions have formal rules and informal norms with their enforcement characteristics.

Institutions, with a definite structure of economy, increase feasibility and profitability during an economic activity. Institutions offer a reliable and structural way of communication with incremental changes. In best institutional frameworks, changes occur due to modification in the mindset of economic and political entrepreneurs. Better knowledge, factual data and variability of valuable attributes provides the way for maximum dependence on institutions for a structured and low-cost exchange.

Institutions are formed with formal and informal constrains along with their enforcement mechanism. Institutional and technological interactions define transaction costs that are summed up to proclaim production cost. In a society, the major aim of the institution is to reduce uncertainty by developing a stable and efficient structure for human interaction. Institutions are evolved through different conventions like: legal procedures, individual

contracts, norms of the state and general laws.[140] Therefore, institutions change available choices. Change in institution is a difficult process because changes at the margin may lead to a change in rules, informal constrains and enforcement effectiveness.

In Douglas North institutional approach, institutional theory is originated from two combined theories, first one is the theory of human behavior and second one is the theory of transaction cost. Evidently, in human co-operation, the major role of a social institution is to limit uncertainty by providing structure for life.[141] The two levels on which institutions serve are:

1. Informal Constraints are based upon culture, habits and incentives
2. Formal Constrains are based upon constitution, law and property rights

Persistence plays a role in institutions. It emphasizes that the purpose of an institution is to provide stability and predictability to human behavior. Through rules and regulations, institutions constrain human behavior. Institutions have the capability to detect divergence from defined rules and regulations. Institutions form rules based on both legal and ethical considerations which define constrains for human action and ensure their enforcement.[142] Through structured ways, institutions impose constrains on human interaction. This way, institutions define the incentives that determine the action of individuals and determine the performance of a society and its economy over time. Institutions signify the firm rules and regulations of the game. No society is devoid of institutions.

Douglas C. North highlights the importance of institutions and their role in economic development. In order to understand role of institutions in economic development, it is necessary to understand the evolution of trade. In early times, individuals had limited trade which was based on close geographical proximity. At that time, trade was possible only

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[140] Douglas C. North, *Institutions, Institutional Change and Economic Performance*, (New York: Cambridge University Press, 1990), pp. 3-10

[141] Cosmin Marinescu, "Transaction Costs and Institutions' Efficiency: A Critical Approach", *The American Journal of Economics and Sociology*, Vol. 71, No. 2, (2012), pp. 254-255

[142] Douglas C. North, "Transaction Costs, Institutions and Economic History", *Journal of Institutional and Theoretical Economics,* Vol. 140, No. 1, (1984), p. 8

among those who were reliable in terms of cash or delivery. Trade with strangers and over a long distance was not possible. Institutions resolved this issue and the trade reached its current magnitude of global level. The economy was based on personal exchange only. In order to shun fraudulence, deception and cheating, people traded only with those whom they knew well and they were in proximity. Then, the size of market was very small for limited numbers of people traded with small trading items.

The notion of specialized interdependence is the opposite of personal exchange. Under the notion of specialized interdependence, one may trade with a person who is residing on the other side of the globe. Today, people trade without the fear of being cheated. By the bliss of innovations like property rights, enforcement of contracts and modern infrastructure of transportation, people confidently get involved in trade over large distances. At present, acquiring of personal information regarding geographic proximity for trading activities is not required. This thing dramatically increased the size of potential market. As markets are growing bigger, the chances of cheat and fraud are increasing. A cheater from one market may go to another market for exchange. In this larger market system, due to low enforcement mechanism of rules and regulations, third party enforcement is being sought. Creation of third-party institutions are necessary for large level trade with strangers round the globe. These third-party institutions reduce security risks by creating potential security system in different forms of transactions. Labor laws and increasing specialization involve the growth of institutional structure that may allow individuals to get involved in complex relationships based on personal knowledge. As said earlier, the development of institutions is necessary to reduce uncertainties associated with more complex social frameworks.[143]

Information possessed by actors leads to the formation of institution. Neo-classical theory postulates that information necessarily helps actors choose best alternative options correctly in making choices for the achievement of desired results. Transaction costs rise due to costly information and asymmetrically held goods by the parties in exchange. Institutions are developed to structure human interaction which may result in some degree of markets'

[143]Douglass C. North, "Institutions and Economic Growth: A Historical Introduction," in International Political Economy Perspectives on Global Power and Wealth, By Jeffry Frieden and David A. Lake, eds. (New York: Routledge, 2000), pp. 48-49

imperfection. In term of trade, institutions provide structure incentives to the participants through correct choices and thus reduce transaction costs.[144]

Economic prosperity of a state is based on the quality of its institutions. Institutions are necessary for economic progress. The desire of every state is to achieve high economic growth rates. Third world countries are poor because the structure of their institution does not encourage active production. In developing world, it is important to encourage overall institutional framework which ensures overall economic development.

***In the structure of law, previous decisions become embedded.***

Process of Institutional Change: Institutional change is a difficult task because changes at the margin can become a cause of changes in formal constrains, informal constrains and, as a result, it will affect enforcement mechanism. Institutions usually change incentives instead of discounting culture. It is possible to change formal rules overnight due to political or judicial decisions. Change in informal rules is not possible because they are embodied in customs, traditions and code of conduct. These informal rules not only develop a relationship of past with present and future but they also provide a way for understanding historical change.

There are two factors determining the path of institutional change. First is increasing return and second is imperfect market characterized by significant cost of transaction. Institutions don't matter, where markets are competitive and institutions receive no increasing returns. But, in a world where there is increasing return, institutions matter. Institution matters, where there is increasing return and, in such situation, institutions provide long term path of economic development. On the other side, if markets are unable to compete, the information feedback is fragmentary at best and the costs of transaction is significant; the subjective models of actors, modified both by much imperfect feedback and by ideology, will shape the path. Then, not only divergent paths but poor persistent performance will also prevail.

[144] Douglas C. North, *Institutions, Institutional Change and Economic Performance,* op. cit., pp.107-108

Institutional change can be understood by focusing on the development of common law as a form of institutional change. Precedent base of common law provides persistence and predictability that is crucial for the reduction of uncertainty among contracting parties. In the structure of law, previous decisions become embedded. So, changes are marginal for new cases or unforeseen issues arise as a part of legal framework. Court-decisions reflect the subjective processing of information in historical context as a source of development for legal framework. However, judicial process modifies institutional framework by the progressive activities of organizations.

Gradual institutional changes occur through continuous marginal adjustments. The emphasis is deliberate on such changes. It is a prominent way through which different economies and societies evolve. Discontinuous institutional change, through revolution or conquest, is also crucial. The persistence of institutional constrain survival, before radical alternation in the formal rules of game, is the best way of increasing return features of an institutional framework.

Technological development and institutional change is a key to economic and societal evolution. It presents the characteristics of path dependence. Actors' perception plays vital role in technological and institutional changes. Ideology is important in subjective construction of models that define choices. In an institutional context, choices have multiple aspects caused by the complex nature of relationship between formal and informal constrains. As a result, both institutions and technology are locked together. Path independence appears much more complicated for institutions rather than technology.[145]

## Institutional Theory Applied on Energy Governance of Pakistan

**In this study the notion of 'Energy governance," taken to mean national collective action and efforts (the informal and formal narratives and actions) undertaken to manage and distribute energy resources and provide energy services. That offers a meaningful and useful framework for assessing energy-related challenges in Pakistan.**

[145]Ibid., pp. 95-104

Economic prosperity of a state is based on the quality of its institutions. According to the theory of institutions offered by Douglas North the institutions have two characteristics in behavioral perspective (see Table 2.1) referred Pakistan. Economic institutional structure[146] is important because it serves as a pre-condition for efficient economic performance.[147]

The theory has two levels of analysis as follows:

- ☐ Informal institutions involve social norms, customs and behavioral rules
- ☐ Formal institutions include law, organizations and economic agents.

**Table 2.1 Dimensions of Institutions vis-à-vis Energy Governance referred Pakistan**

| | **Dimensions of Institutions/Governance** | **Dimensions of Energy Governance of Pakistan** |
|---|---|---|
| 1. | Informal Institutions: Set of rules socially shared and communicated | Energy in manifestoes and policies of political parties in Pakistan |
| 2. | Formal Institutions: Set of rules regarding the repetition of activities, constancy and the order of predictability | NEPRA, WAPDA, KESC, PCAE |

Source: Self Extract

Ad-hoc decision making is the significant trait of energy governance of Pakistan.[148] Particularly the political institutions; either the informal or the formal are prone to fix energy on their political agenda for political benefits. The energy crisis is realized as part of every political party's manifesto in Pakistan but the realistic and persistent will to diminish the crisis is found lacking. It can be questioned that: Why 'Independent Power Producing' project was signed by the 'Pakistan People's Party' in 1994; Why 'China-Pakistan Economic Corridor' project was signed by the 'Pakistan Muslim League (N)' in 2015 disregarding its cost benefit in financial and environmental terms? Why Kalabagh dam has not been constructed to have water and energy security equally? The answer is one:

[146]The Institutional Structure is Comprised of more than one Institutions.

[147]Pasquale Tridico, "Institutional Change and Economic Performance in Transition Economics: The Case of Poland", *Sussex European Institute*, (2004), p. 4

[148]Hamid Hasan Mirza, "An Overview of Pakistan's Energy Sector: Policy Perspective", in Solutions for Energy Crisis in Pakistan, ed. Mushir Anwar, *Islamabad Policy Research Institute*, (2013), p.7

**Prevalent set of rules socially shared and communicated;**
**Manifestoes and policies of political parties in Pakistan**

Energy was major agenda of elections of Pakistan People's Party in 2008 and of Pakistan Muslim League (N) in 2013 but their consequent rules proved unable to resolve the issues of energy security. On April 25, 2014 Prime Minister Nawaz Sharif announced the end of energy crisis within three years. Next year on March 22, 2015 the same Prime Minister reported that "most of his government's time is consumed in tackling terrorism and the acute energy crisis which leaves little time for development works".[149]

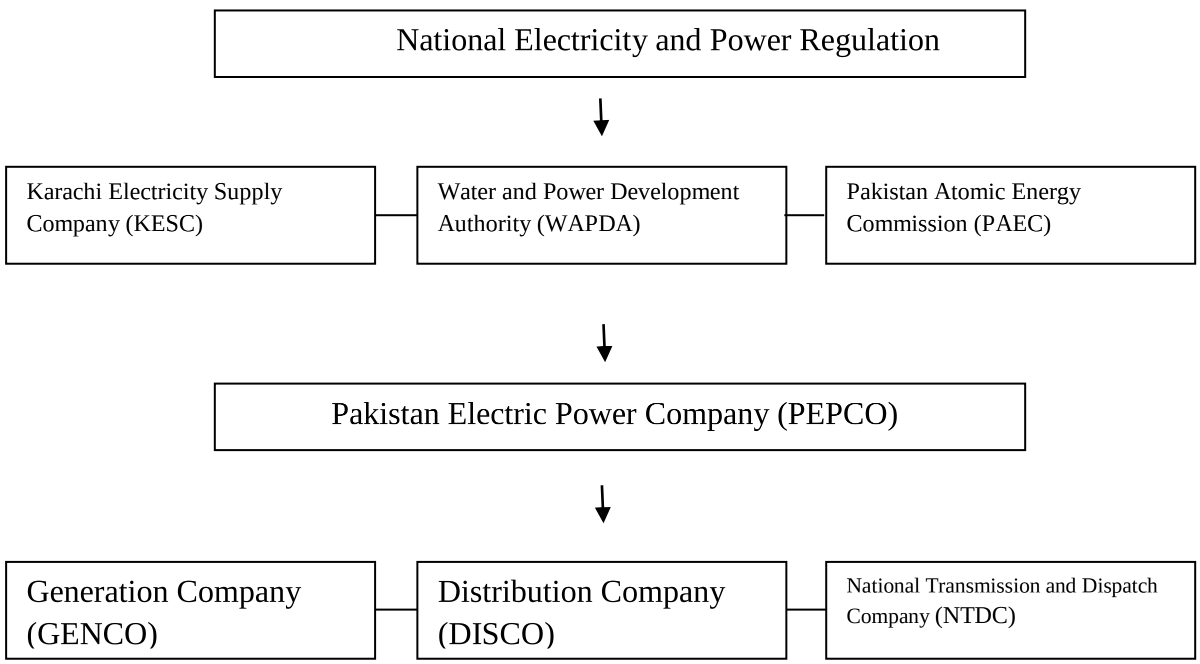
In the energy history of Pakistan enormous high-level committees and task forces have been established to frame energy strategy; they came up with outputs but found without the outcomes. The results could be noticed in terms of visibility of certain institutions but the outcome of energy security in terms of affordability and environment friendliness is found rare. In the absence of comprehensive energy policy, the issues of: appropriate energy mix, affordability, certain energy supply and balance between choice and cost of energy technology are not found the priority of energy governance of Pakistan. Energy policies formulated since 1994 are mostly found short-sighted solutions in between political and bureaucratic interests. Ioannis N. Kessides writes, "Pakistan's energy bankruptcy is ultimately due to massive institutional and governance failure".[150]

With the rise in the demand of energy, many states have restructured their energy sector by restructuring their institutional setup. However, this process of restructuring varies from state to state. It is different for under-developed, developing and developed states. It is based on the policies of state-run institutions. The mindset of energy governance (See Fig 2.1) of Pakistan favors short-term solutions to resolve energy crisis of Pakistan. The energy governance of Pakistan is caged by specific political mindset, centralization, enormity of energy producing companies, lack of link with academia, lack of focus on alternative sources of energy, lack of climate literacy, lack of long-term energy plans, and dependence on foreign

[149]Nawaz Sharif, "Terrorism, Power Issues Keep Nawaz Perplexed", *Dawn*, (22 March 2015)
[150]Loannis N. Kessides, "Chaos in Power: Pakistan's Electricity Crisis", *Energy Policy*, Vol. 55, (2013), p. 275

investment. This mindset favors short-term solution of prevalent problem of energy. Energy sector is facing worst energy mix that results in high cost of production which is sure to put negative impact on economy. The nature of this impact is dual for it increases both unemployment and inflation.

**Figure 2.1 Energy Governance in Pakistan**




Prior to discuss energy governance style of Pakistan, facts regarding energy governance of USA and China are hinted upon. In United States, there is no single body which sets rules for energy sector. Regulation of wholesale markets is the responsibility of federal government. United States has various energy policy acts to control wholesale energy market manipulation. These acts are an outcome of Federal Power Act of 1935, Energy Policy Act of 2005 and Federal Energy Regulatory Commission. Under the governance of these acts, energy system of US regulates the production, the transmission and the distribution of energy. It is the responsibility of US congress to regulate the overall energy system of US. Federal

administrative agencies imply the decisions of US congress for the said regularity.[151] Interstate energy sales and services are regulated by Federal Energy Regulatory Commission of US. This commission works under federal government. Facility planning, siting and retail energy services are regulated by public utility commission. This commission is run by state governments.[152] In the retail market of China, there is no significant competition over production and transmission of energy. There are five state owned generators. These generators generate the overall energy chain to energize China. Southern Grid and State Grid are two state owned grid companies those are responsible for overall transmission and distribution of energy.[153] Like energy regulatory authorities of US and China, regulation of energy sector of Pakistan is the reasonability of National Electric Power Regulating Authority (NEPRA).

National Electric Power Regulating Authority (NEPRA): In institutional setup of energy sector, National Electric Power Regulating Authority-NEPRA is a formal institution which formulates policies to regulate the overall energy system of Pakistan. In December 1997, an act of parliament formalized the status of NEPRA. Through this act, structure of NEPRA governance was spelled out. To govern the institutional structure, NEPRA has a chairman who is appointed by federal government. It also has four members who are appointed by and from all the four provinces by the federal government with the consultation of provinces.

In its legislative structure, NEPRA claims that it strikes a balance between interests of service providers and the consumers of energy. However, it is far from reality and it contradicts the facts. For, the provision of the service by NEPRA is distributed among various organizations. Therefore, for NEPRA, it is an irksome task to create a balance among these organizations. The institutional structure of NEPRA is an amalgam of various people who are

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[151] "Electricity Regulation", Available At: https://www.lexology.com/gtdt/tool/workareas/report/electricity-regulation/chapter/usa Access on 1-6 2019

[152] "Electricity 101", Available At: https://www.energy.gov/oe/information-center/educational-resources/electricity-101 Access on 1-6-2019

[153] Yingying Zeng, Stefan E. Weishaar and H. B. Vedder, "Electricity Regulation in the Chinese National Emissions Trading Scheme (ETS): Lessons for Carbon Leakage and Linkage with the EU ETS", *Climate Policy*, Vol. 18, No. 10, (2018), p. 1248

laymen for energy sector and they do not have much understanding of energy system. They lack the required competency in every aspect of their field like: energy sector experience, competency, enforcement of rules and human resources. Also, the regulatory affairs of NEPRA are not relevant to ground realities and requirements.[154]

The centralization of PEPCO negatively influenced NEPRA in its financial management, energy purchase and sales and in the appointment of senior management over its operating companies (GENCOs and DISCOs).[155] Because of the inefficiency of NEPRA, energy supply is restricted. NEPRA is found inefficient in its decision-making procedure. On the other hand, in order to attract private investors, it is necessary that they must be made happy by providing them with incentives by giving them some relaxation in regulatory restrictions.[156] NEPRA is found causing uncertainty: NEPRA was basically established as a regulatory authority. Nevertheless, at present, it is controlling and monitoring energy market of Pakistan. The trade of energy commodities falls in the definition of energy market. So, NEPRA is not a single energy market regulator or a single integrated energy regulatory authority. For the ideal regulation of energy market, a single body is essential which safeguards the interests of all stakeholders the producer and the consumer. NEPRA is autonomous in its respective rules. It is another fact that even these rules are not efficient for rules are a highway to run the things in order. Nevertheless, the rules created by NEPRA create confusion among investors and price planning between oil and gas departments is disturbed.[157]

Public-sector companies also show signs of poor efficiency by producing less energy per unit of used fuel if and when compared with private energy plants. Although, NEPRA understand that inefficiencies and management issues need to be settled down but the government could not impose commercial discipline and accountability on these utilities.[158]

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[154]Ashar Saleem, "State Under Trial, An Institutional Analysis of a Policy Decision in the Pakistani Electricity Sector", *Suleman Dawood School of Business*, (PHD Thesis) LUMS University (April 2015), pp. 86-87
[155]"Friends of Democratic Pakistan", *Integrated Energy Sector Report and Plan*, (2010)
[156]Ibid
[157]Anwer Zeb, Azad Haider and Farzana Shaheen, "Improving Energy Regulatory Framework of Pakistan", *International Journal of Renewable Energy Research,* Vol.5, No.4, (2015), pp. 1070-1071
[158]Rashid Aziz and Munawar Baseer Ahmad, "Pakistan Power Crisis: The Way Forward", *United States Institute of Peace*, (June 2015), p. 8

NEPRA sets targets for all distribution companies but no measures are taken when those targets are not met. These issues mounted up circular debt. Ultimately, the government ends up paying for these additional losses in order to clear circular debt.

Water and Power Development Authority (WAPDA): From 1958 to 1992, WAPDA wholly solely controlled the energy sector of Pakistan. In those years, WAPDA was responsible for production, transmission and distribution of energy. In the later years, the gap between demand and supply started to widen. Performance was poor because the customers were not satisfied, the corruption had set in and the institution was unable to fill the gap between demand and supply. The system of WAPDA was poorly managed and unorganized. The institution of WAPDA was facing managerial problems which cannot be resolved through financial assistance or substantial budget. The institution is found incapable of managing production and distribution.

The system of WAPDA was controlled by headquarter, based in Lahore. For a vast country like Pakistan, centralization of energy system may decrease the efficiency and poor efficiency, ultimately, affects performance of the institution. For example, top management of this institution deals with diverse energy issues and increased work load on staff may result in arbitrary decisions which, in the long run, may compromise on the development of country. Mismanagement and slow working processes provide space for favoritism, nepotism and corruption.[159] In energy sector, public sector companies showed poor performance, high inefficiency and dependence on financial support of government.[160] Till 1992, energy sector was controlled by WAPDA only. Institutional changes of energy sector were greatly motivated and financed by World Bank, IMF and ADB. WAPDA was financed when it was unable to manage its unmanageable infrastructure of energy system.[161] As a result of these changes, WAPDA was unbundled into production, transmission and distribution sectors. Unbundling of WAPDA resulted in the creation of ten distribution companies (DISCOs), four

[159]Zainab Khalid and M. Iftikhar-ul-Husnain, "Restructuring of WAPDA: A Reality or a Myth", *The Pakistan Development Review*, Vol. 55, No. 4, (Winter 2016), pp. 352-354

[160]Kafait Ullah, "Electricity Infrastructure in Pakistan: An Overview", *International Journal of Energy, Information and Communication*, Vol. 4, No. 3, (June 2013), p. 14

[161]G. Tomassi and O. Timone, "Il misantropo. Eitrgeur Altertumskunde" (New York: DE Gruyter, 2011), p. 598

generation companies (GENCOs) and one transmission and dispatch company (NTDC). Despite the taking of these steps, energy sector remained heavily under public monopoly. System of NTDC mostly remained under strict monopoly of government. The private sector was attracted by thermal energy production. But the function was limited due to certain restrictions on investment and regulation of prices. Projects of hydro energy production were opened for private sector, but the functioning of the projects was dependent on WAPDA and government for financial assistance.

Management requires a lot of work in quick succession and thus the decision comes in haste and quality drops to abyss. The developed nations like Malaysia, Korea, Chile, England and US have successfully managed all their issues related to their energy sector by enriching institutional management with effective enforcement. However, Pakistan, as a developing nation, still lacks the enforcement of institutional policies.

Analysis of the energy institutions of developed states shows that effective institutional management from top to bottom increases the possibility of success of energy development to maximum. Effective institutional management and inclusion of fresh reforms in existing policy structure may improve performance of energy sector. In energy sector of Pakistan, pace of market-based reforms and privatization is slow.

**Karachi Electricity Supply Company (KESC):** In 1913, KESC was setup under 1882 Indian act. In 1952, major share hold of KESC was owned by government. In 2005, KESC was privatized. In 2012, KESC, in its history, earned some profit, for the first time. This happened because of effectiveness of better load shedding management plan and improved infrastructure.[162]

After privatization of KESC, it was expected that it would become efficient. However, it didn't meet the expectations and it had to face various institutional challenges and proved

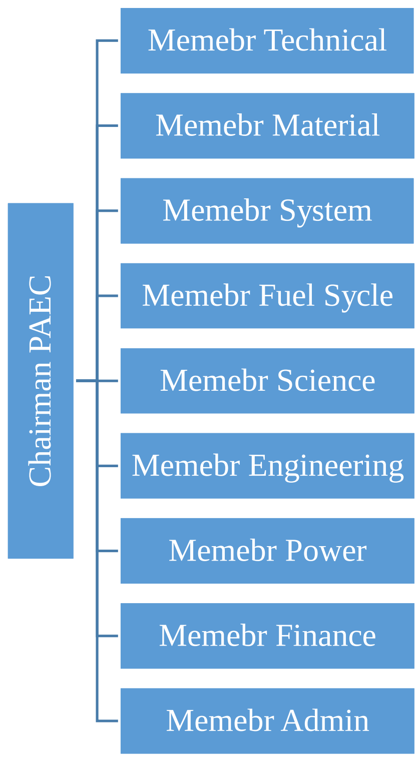
[162]Amir Jahan Khan, "Structure and Regulation of the Electricity Networks in Pakistan", *The Pakistan Development Review*, Vol. 53, No. 4, (Winter 2014), p. 31

unable to fulfil the rising energy demands. The performance invited at the hands of media and dissatisfaction increased stress among energy users.[163]

Pakistan Atomic Energy Commission (PAEC): In Pakistan, PAEC was setup in 1955. Energy production through nuclear technology is under the control of PAEC. Its function includes the conduction of research on usage of nuclear energy for peaceful means especially for energy production, add into energy mix of Pakistan. It works under the guidance of government and Figure 2.2 defines the organizational chart of PAEC.

**Figure 2.2**

**Organizational Chart of PAEC**




**Source**: IAEA, Country Nuclear Power Profile, (Pakistan), Available at: https://www-pub.iaea.org/MTCD/Publications/PDF/cnpp2018/countryprofiles/Pakistan/Pakistan.htm Access on: 31-5 2019

Under PAEC, there are seven nuclear energy plants. Five plants are operating while two are under construction. These plants have 1,430 MW gross capacity. During first eight

[163]Arshad H Abbasi, "Pakistan Power Sector Outlook: Appraisal of KESC in Post Privatization Period", *Sustainable Development Policy Institute*, (2011), p. 1

months of FY 2017-18, these plants supplied around 5,811 million valuable units to national grid. To meet the growing energy demands, PAEC is planning to increase its activities for provision of energy. By 2030, through nuclear technology, PAEC has a target of producing 8,800 MW of energy.[164]

Applications of research related to nuclear energy is the responsibility of PAEC. Nuclear power program is the responsibility of two divisions namely Nuclear Power Projects (NUPP) and Nuclear Power Generation (NUPG). Directorate of NUPP is concerned with construction and design of planned units and directorate of NUPG supervises operational units.[165]

PAEC is powerful and well-coordinated. In Pakistan, PAEC is a single institution which shapes policies and leads institutions towards nuclear energy production. This institution has political power and is fully authorized to deal with over all issues related to nuclear power. Thus, since its inception, with the start of peaceful nuclear program, PAEC is ensuring both national security and technological progress. As a matter of fact, in 2005, PAEC bluntly refused to present its budget before parliament. It also dominates major scientific activities in terms of research and financial resources access. In its institutional capacity, historically, it influences science related policy making, national security and production of energy using nuclear technology. It has a monopoly of nuclear related expertise and is unchallenged by government, civil society and even public. However, it is a fact that this institution gets significant share in annual budget and functions as a state within the state.[166]

Energy crisis of Pakistan is the byproduct of reckless attitude of governments and their poor institutional policies. This crisis has inflicted the society with various social, economic, political and strategic losses. The hurdle, in the form of institutional policies, is the most prominent reason for such kind of a crisis. These institutions, in existing policy framework,

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[164]Pakistan Economic Survey 2017-18, p. 14

[165]"Nuclear Power in Pakistan", (May 2018), Available At: http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/pakistan.aspx Access on 31-5-2019

[166]Zia Mian and Abdul H. Nayyar, "Pakistan and The Energy Challenge", *International Perspective of Energy Policy and the Role of Nuclear Power*, (Essex: Multi Science, 2009), pp. 546-548

are not capable to deal with the energy crisis. The pathetic characteristics of institutional polices have brought Pakistan on the verge of worst energy crisis.

Almost all reasons behind scarce energy supply are intricately intermingled. Institutional governance is a process of making decisions and implementing them with efficiency and under strict accountability. However, a detailed discussion on the factors behind insufficient supply shows that most of the problems ranging from circular debt, tariff determination and decision making to mismanagement inefficiency are a result of institutional mismanagement. Pakistan suffers from institutional and structural disconnections and mismanagement in the priority of issues.[167] Hence, policies posed immense damages, either by approving public investment inappropriately or by misappropriating extremely essential projects.

***The Energy Governance of Pakistan Assumes:*** Energy projects of CPEC are considered to provide affordable and clean energy. The major portion of foreign investment of $34 billion has been allocated for energy production and its transmission to fulfil energy demands. Fund of CPEC is the largest foreign investment in Pakistan which will enable it first to attain and then maintain energy security. The energy projects of CPEC will provide affordable and cheap energy in a diversified way. Cost of a single imported coal-based unit will be Rs 8.5/U followed by local coal Rs 8/U, LNG fuel RS 9.5/U, Solar Rs 5/U[168] and hydro Rs 5.17/U.[169]Under CPEC, power plants tariff will be reduced sharply form Rs. 15-18 to around Rs. 8 per unit.[170] Top priority of CPEC is to equip Pakistan with reliable and affordable energy technology to attain energy security. In CPEC energy projects four sources, coal, hydel, wind and solar are being utilized. 69% share of coal is extraordinary followed by Hydro-power 21%, Solar 7% and Wind 3%.[171]

***The Energy Governance of Pakistan Assumed:*** Energy investment of CPEC has not only boosted the confidence of the government but it has also encouraged private sector

[167]"Friends of Democratic Pakistan", Op.cit.
[168]Zamir Ahmed Awan, "Taking Stock of Power Projects under CPEC", *China-Daily*, (5 September 2018)
[169]Shahbaz Rana, "PAC Demands Briefing on CPEC Power Projects", *Express Tribune*, (2 January 2019)
[170]http://corridor.pk/2018/12/31/chinese-embassy-provides-details-on-the-latest-progress-of-cpec/ Access on 20-1-2019
[171]China-Pakistan Economic Corridor (2017), Available At http://cpec.gov.pk/ Access On 25-5-2017

investments. If energy projects of CPEC get completed in its proposed time, energy crisis would fall to a significant level. In future, 8% surplus demand of energy is expected. It is expected that, in 2020, the demand of energy may reach to 44000MW.

***The Energy Governance of Pakistan Assumed:*** Analyzing post-CPEC energy situation, it is notable that a share of renewable energy in the energy mix of Pakistan is being added gradually. The share of solar (7) and wind (3) is a big step in the progress towards renewable energy. Another key accomplishment is the reduction in the reliance of imported furnace oil. As it is a big burden on economy, its import must be declined and its import is declining.[172]

***The Energy Governance of Pakistan Assumed:*** Energy projects of CPEC, adding the bulk of energy-to-energy production, are sure to address energy scarcity of Pakistan. Through CPEC energy projects, Pakistan will be able to manage its economic crisis. In 2014, before the inauguration of CPEC energy projects, the per unit cost of energy was PKR 9.69, at present it is PKR 15.53 but in 2020 it is expected that the per unit cost of energy will be reduced to PKR 9.10. There is a profound link between energy and development. Both are fundamental to the economic development of a state. A strong combination of these factors leads a state towards energy security and thus sustainable progress. According to NEPRA, through CPEC energy, there will a shift of energy mix from expensive oil-based generation (Tariff: PKR 10. 4506/KWH) to coal-based generation (Tariff: PKR. 8.117/KWH).[173] Currently, share of coal in energy mix of Pakistan is low. Consumers are paying high cost of $0.15 per unit, compared to $0.09 in Bangladesh, $0.11 in China and $0.12 in India.[174]

Through the assessment of informal and formal institutions states can gain long run and sustainable energy development. In energy sector, institutions promote long term certainty and enable investments in energy plants through good governance. Academic researches and experiences confirm that countries with strong and efficient institutional

[172]Energy Dependence: "CPEC and Pakistan's Energy Portfolio", *Institute of Policy Studies,* Brief No. PB-2018-VI JN, (28 June 2018), p. 5

[173]Yasir Arrafat, "Challenges and Solutions in Building CPEC-A Flagship of BRI," *Centre of Excellence, China-Pakistan Economic Corridor*, Working Paper No. 17, (2017), p.6.

[174]Harris Azhar and Amna Syed, "Impact of China-Pakistan Economic Corridor (CPEC) on the Energy Sector of Pakistan", *Pakistan-China Institute*, (2017), p. 17

frameworks have strong and efficient energy traditions. A long-term and efficient energy strategy helps plan and response to energy crisis. On political fronts, lack of political will and controversies between provincial and federal governments are linked to quality of political will to acquire energy security. Contemporary energy governance of the country is based on constitutional, political, economic and administrative institutions. Political parties have different views regarding energy sector reforms.

Management requires a lot of work in sustainable decision making. The developed nations like Malaysia, Korea, Chile, England and US have successfully managed all their issues related to their energy sector by enriching institutional capacity to view the experience and future challenges. Analysis of the energy institutions of developed states shows that effective institutional management from top to bottom increases the possibility of success of energy development to maximum.

The discussions in chapter 2 takes the study to establish that the capacity of institutions empowers the states to plan the economic security based on element of energy. As per the dimension 1 of the energy security index, "Energy Production Dependency: Know how, as measured by availability (one third weight) and utilization (one third weight) of energy resources as per set of politics (one third weight)," applied in the study the state of Pakistan possesses the informal and formal politic-economic institutions with the least capacity to perceive the energy crisis of Pakistan keeping in view the past experience and future challenges. The findings are based on facts of non-alignment of expectations and actions of the individuals in informal and formal institutions of energy governance, lack of coordination among formal institutions, in-evidence of mutual benefit. The energy available is neither affordable nor clean; irrespective of the $34 billion CPEC project 2015 to diminish the energy crisis of Pakistan.

In chapter 3 Causative Factors of Energy Crisis of Pakistan: Socio-Economic Development, Global Climate Change Impact, and Challenges to Energy Governance would be discussed. The deliberations would lead the study to establish percentage of variance of each of the three variables as responsible factor causing energy crisis in Pakistan.

# Chapter 3

## Causative Factors of Energy Crisis of Pakistan

### I. Socio-Economic Development in Pakistan and Energy Crisis

### II. Global Climate Change Impact on Pakistan and Energy Crisis

### III. Maladies in Energy Governance of Pakistan and Energy Crisis

The Energy Governance gets Affected by the Maladies of:

Complex Decision-Making
Multiplicity of Institutions in Energy Governance
Incorrect Energy Mix,
Centralized Energy System
Legal Constraints
Technological Barriers
Circular Debt
Price Determination Mechanism
Fragile Security Situation
Malady of Poor Transmission and Distribution (T&D) System

# Chapter 3

## Causative Factors of Energy Crisis of Pakistan

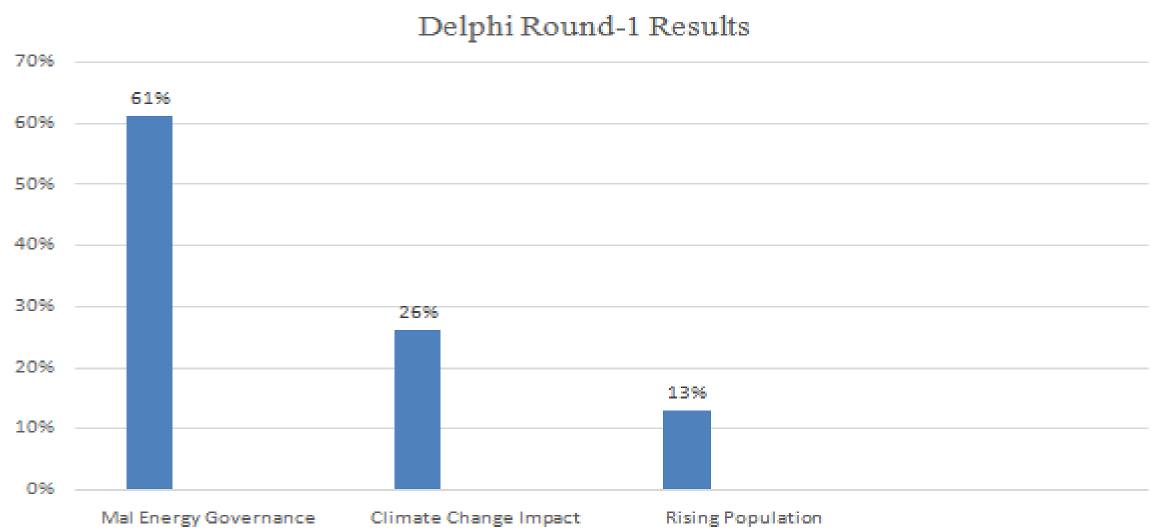
Real premise of the study pondered: to enumerate the causative factors of energy crisis of Pakistan and explain their variance in comparison to each other. The purpose is to identify real determinants of the crisis of energy and its relationship to CPEC. The causative factors deliberated are: socio-economic development, climate change and challenges to energy governance. The significance of each variable causing energy crisis is discussed. The study relies on knowledge and opinion of experts obtained by utilizing Delphi focused method (See Annexure I) to prioritize the variables of the study. Chapter 3 moves from generally understood reasons of energy crisis e-g socio-economic development, and climate change to specific reason of energy crisis e-g, mal energy governance discussed as prime factor causing energy crisis. The questions like, Why Pakistan allowed foreign investment in energy in 1994 and 2002? What is the point for Pakistan of allowing China to fund and build the CPEC energy projects? On what calculations did Pakistan base it's signing of the CPEC in 2015?' are focused here. Nonetheless increase in the energy production was the only objective and not the distribution. Pakistan produces 37000 MW and has the distribution capacity of 22000MW only.[175] The priority is based on results of Delphi round 1 (See Figure 3.1). 61% experts determined the mal energy governance the first reason, 26% called climate change impact the first reason, while 13 recognized socio-economic development in sequence to rising population the first reason responsible for energy crisis of Pakistan.

In chapter 1 and 2 it is described that energy is pinnacle of economic strategy of states in international relations. In this case, the ESI was applied on the energy security of Pakistan to determine the probability of energy crisis. The visibility of energy crisis pervades the quality population of a state. The indicator of affordability as far as price of energy and purchasing power parity is legitimately pertinent to general population. However, when it comes to the issues and hitches of common man in the absence and deficiency of energy security, it is not only confined to affordability but has particularly broader range. In this chapter, the elements of common man are examined, before delving into the subtleties of

[175]Maha Rehman, "Pakistan's Electricity Generation has increased over Time. So Why do We Still not have uninterrupted Supply", *Dawn*, (10-06-2019)

other important elements of ‘Energy Security and Energy Crisis’. In order to exhibit that why accomplishment of energy security in Pakistan is necessary, this portion explicitly centers around the implications of energy crisis on common man. It starts with the connection among economy and energy development which manifests that how the crisis of energy influences the development of economy as such subsequently reducing economic growth affects in various manners.

**Figure 3.1: Causative Factors of Energy Crisis of Pakistan**




The best example of significance of continuous and uninterrupted energy supply was acknowledged and comprehended when Arab countries imposed serious embargoes on US and other western countries which severally harmed their economy, specifically of USA. After this challenging stroke from Arab countries, since 1973, US began to explore alternatives, elective, sustainable and renewable energy sources. The states consideration to ascertain energy usage and economic growth relevant to hike in energy, petroleum and other energies, depleting resources, quest for the alternative sources and energy efficiency and saving policies. The relationship and connection between energy and economic development is extensively shrouded in insightful writings of scholarly literature at international and national level. The significance of energy is that it is not only fundamental for economic growth but, additionally, it is also an indispensable part of social development. It suggests that

the development of society is connected to the development of economy which relies upon energy. The larger part of literature has demonstrated and proven constructive connection among the growth of energy and economy.

Laumas and Williams discovered a solid indication in the provision of energy-economic connection in case of India.[176] Ghosh built up that for India, that the connection among the development of energy and economy is paramount from economic growth.[177] This conclusion is seen as reliable with the research carried out by the Industrial Development Services (IDS). In case of USA, it reported the evidence that the consumption of energy is connected to the economic growth.

A Central American research concluded by Apergis and Payne discovers connection running among consumption of energy and the growth of economy. Whereas in quite a while ago run there is a unidirectional connection which runs from consumption of energy to the growth of economy which imply that the expansion in the consumption of energy prompts better economic outcomes. According to Stern, who holds the opinion through time series analysis that there is a co-integration connection among the growth and development of economy and energy. Therefore energy, alongside different variables of production elicit economic growth. However, the outcomes could be extraordinary if suitable research and examination is done based on per unit energy consumption. Explanation behind this disparity is that better energy efficiency may have decreased per unit or per capita energy utilization despite the fact that more energy was expected to perform an easy task because of poor quality of fuel. Working productivity and efficiency of the machinery and equipment has expanded and now they use less energy.

Farhani and Ben Rajed conducted research on 95 countries of time period 1971-2008. They extensively divided these countries into four income groups. They discovered a protracted connection among GDP and energy. For countries having low and high income, the relation is from GDP to energy which means that GDP development elicits more energy

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[176]Prem S. Laumas & Martin Williams, "Energy and Economic Development", *Weltwirtschaftliches Archiv*, Vol. 117, No.4, (1981), pp. 706-716

[177]Sajal Ghosh, "Electricity Consumption and Economic Growth in India", *Energy Policy*, Vol. 30, No. 2, (2002), pp.125-129

utilization. Although considering the countries having middle and lower middle income the course of effect is bidirectional which means that both energy and economic growth become circumstances and logical result for one another. The study shows that results were distinctive for different countries. Asafu-Adjaye additionally exhibited in his work on Asian countries where he discovers that there is a unidirectional effect of consumption of energy on the growth of economy in shorter term for Indonesia and India.[178] Whereas considering that for Thailand and Philippine, the relationship is bidirectional. Sadorsky [2009] with the implementation of panel error correction model estimated bidirectional relationship between the growth of economy and consumption of energy for 8 developing economic markets.

Ighodaro conducted an extensive research on Nigeria which concludes that there is unidirectional fundamental connection among the growth of economy and energy. He utilized data ranges from 1970 to 2005.[179] A research carried out by Erdal and Esengun for Turkey concluded that there is a bidirectional relationship between energy consumption and GDP.[180] Another research done on Turkey by Altinay and Kargol stated that the effect spilled out from energy to economic growth which means that energy prompts economic growth, so it concluded that, when there is more energy utilization greater will be the economic growth.

In the connection among the growth of economy and energy in South Asia, Siddique and Majeed express that there exists a protracted relationship between growth, energy, trade, and financial development.[181]In the specific context of Pakistan, numerous studies highlighted the effect of energy on the development of economy. As energy utilization can lead to a better and improved economic status, Aqeel and Butt infer that energy has crucial role in economic growth.[182] While carrying research on Pakistan, Siddique forwards the argument that

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[178]John Asafu-Adjaye, "The Relationship between Energy Consumption, Energy Prices and Economic Growth: Time Series Evidence from Asia Development Countries", *Energy Economics*, Vol. 22, No. 6, (2000), pp. 615-625

[179]Clement AU. Ighodaro, "Co-integration and Causality Relationship between Energy Consumption and Economic Growth: Further Empirical Evidence for Nigeria", *Journal of Business Economics and Management*, Vol. 11, No.1, (2010), pp. 97-111

[180]Gulistan Eedal, Hilmi Erdal, and Kemal Esengun, "The Causality Between Energy Consumption and Economic Growth in Turkey", *Energy Policy*, Vol. 36, No.10, (2008), pp. 3838-3842

[181]Muhammad Abubakar Siddique and Muhammad Tariq Majeed, "Energy Consumption, Economic Growth, Trade and Financial Development Nexus in South Asia", *Pakistan Journal of Commerce and Science*, Vol. 9, No. 2, (2015), pp. 658-682

[182]Anjum Aqeek and Mohammad Sabhiuddin Butt, "The Relationship between Energy Consumption and Economic Growth in Pakistan", *Asia-Pacific Developmant Journal*, Vol. 8, No. 2, (2001), pp. 101-110

increased energy supply is connected to a higher economic growth whereas its crisis would minimize or hinder the economic growth. She likewise affirms that implications of all energy sources are not mandatorily the similar. Petroleum and specifically electricity are exceptionally corresponded and fundamentally significant for economic growth.[183] Razzaqi, Bilquees and Sherbaz have also emphasized on the significance of energy in GDP growth and economic development.[184]

Economic development upgrades and elevates the quality of life which implies that the connection among utilization of energy and the quality of human life is significantly positive. For example, in a research of 60 most populated countries of the world, Psternak discovered that the degree of human development remained at most significant level when the per capita energy utilization was about 4,000 kwh. Despite the fact that this is beneath the normal per capita consumption of energy in developed countries, nonetheless, it is likewise path over the standard per capita consumption of energy in developing countries.[185] As indicated by UN HDI, negligible degree of energy per capita consumption is 1,000 kwh while in Pakistan the related stats are 436 kwh. Rhodes has additionally revealed that various social issues, for instance, poverty, health issue and increased violence is caused by the deficient energy supply.[186]

In Pakistan, constant energy insecurity has served as a key reason of numerous social problems. With the growing energy prices, stress, anxiety and depression have increased. There is a decreased working efficiency at offices due to insufficient sleep, which has also undermined the performance of the students. Sometimes families in rural areas are sent bills of enormous amount of hundreds of thousands rupees which according to media reports caused several individuals to commit suicide. Due to such genuine effects of energy crisis on common man, it is essential to contemplate elements of energy crisis in detail.

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[183]Rehana Siddiqui, "Energy and Economic Growth in Pakistan", *The Pakistan Development Review*, Vol. 43, No. 2, (2004), pp. 175-200

[184]Sarwat Razzaqi and Saadia Sherbaz, "Dynamics Relationship between Energy and Economic Growth: Evidence from D8 Countries", *The Pakistan Development Review*, (2011), pp. 437-458

[185]Daniel M. Martinez and Ben W. Ebenhack, "Understanding the Role of Energy Consumption in Human Development Through the Use of Saturation Phenomena, *Energy Policy*, Vol. 36, No.4, (2008), pp.1430-1435

[186]Richard Rhodes and Denis Beller, "The Need for Nuclear Power", *Foreign Affairs*, Vol. 79, No.1 (2000), pp. 30-44

## I. Socio-Economic Energy Development in Pakistan and Energy Crisis

Several variables into the equation required factoring as an objective demand projection. This part will analyse the implications of socio-economic development, i.e., economic growth and population growth.

Growth in population and increasing energy demand and consumption are complicatedly related. According to various scholars, with the increasing size and growth of world population, the demand for energy possibly will not affect as significantly as one might expect. Whereas, conventional approach supported by empirical data, believes that the rising population does lead to increased energy demand and consumption in several ways. Directly, the increases in domestic energy demand will be affected in the form of acquisition of appliances for heating and cooling purposes and other household necessities. If we discuss the indirect implications, it produces expanded economic, industrial and agricultural activities to help such essential luxuries just as extravagance things which lead to increased energy demand and consumption. Thus, among other factors, population exogenously determines energy consumption.

Share of Population in Energy Consumption: In the recent history, there has been an exceptional growth in world population. From 1.13 billion in 1850 to 2.51 billion in 1950, it has been doubled in 100 years, while, reaching 5.32 billion in 1990, it got more than doubled in the 40 years only. From the current 7.7 billion in 2018, it is likely expected to reach 9.5 billion in 2050. This massive population growth has escorted by conforming energy growth and consumption. In his extensive work on the link between population and consumption of energy, John P. Holdren, the renowned American scientist, concludes that "the growth of world population from the year 1850 to 1991 was accountable for 52% of the growth of energy, while growth in per capita in the consumption of energy was accountable for 48% (apart from fundamental relations among population and usage of energy per capita[187] Although down playing the population's role in the growing electricity sector in US, Allan

[187] John P. Holdren, "Population and the Energy Problem", *Population and Environment*, Vol. 12, No. 3, (1991), pp. 231-255

Mazur also coincides that "the overall increase in nonelectric energy over the period 1947 to 1991 is wholly attributable to population growth".[188]

**Table 3.1: Role of Population Growth in Growth of World Energy Demand, 1850-1990**

| Time Period | Average Annual Growth in this Period for: | | | Share of Population in the Growth of: | |
|---|---|---|---|---|---|
| | Population | Industrial Energy | Total Energy | Industrial Energy | Total Energy |
| **1850-1870** | 0.70% | 3.29% | 0.75% | 21% | 93% |
| **1870-1890** | 0.68% | 4.22% | 1.19% | 16% | 57% |
| **1890-1910** | 0.66% | 4.19% | 2.38% | 16% | 28% |
| **1910-1930** | 0.87% | 2.28% | 1.79% | 38% | 49% |
| **1930-1950** | 1.01% | 2.08% | 1.80% | 49% | 56% |
| **1950-1970** | 1.85% | 5.40% | 4.82% | 34% | 38% |
| **1970-1990** | 1.94% | 2.31% | 2.31% | 84% | 84% |
| **1850-1990** | 1.11% | 3.39% | 3.39% | 33% | 52% |
| **1890-1990** | 1.28% | 3.24% | 3.24% | 40% | 49% |

**Source:** John P. Holdren, "Population and the Energy Problem", *Population and Environment*, Vol. 12, No. 3, (1991), P. 245

Table 3.1 highlights that the population is an essential driver of growing demand of energy in both directly as well as indirectly terms. If it is discussed indirectly, population stimulates economy. While extracting from the evident facts, the non-OECD developing countries with growing population have booming economies, and contribute 74% of the increase in global primary usage of energy, however, owing primarily to large rural populations and least-developed energy framework. Various countries in these regions may experience constrained energy consumption growth. Towards the increased energy use, Asia

[188]Allan Mazur, "How Does Population Growth Contribute to Rising Energy Consumption in America?", *Population and Environment*, Vol. 15, No.5, (1994), pp. 371-378

remained as a major contributor. Due to population increase and industrial expansion, the total primary consumption of energy in Asia got doubled from 47.4 quadrillion British Thermal Units (BTU) in 1990 to about 127.1 quadrillion BTU in 2007.[189] With the great transition from agrarian to industrial societies, several other developing countries will also experience increased energy demand.

The relation between population and energy consumption, notwithstanding, may not be unidirectional. According to the findings of Graham Zabel, along with the rise in the consumption of energy and depletion of energy resources in turn, the population growth also triggers search for, and exploration, extraction and exploitation of new sources. As expansion of the Earth's carrying capacity happens because of new sources of energy, it also leads to even more population growth.[190] Thus, both population and energy each transforms the other. Likewise, the factor contributing towards population growth has been rarely studied comprehensively or altogether discounted. High quality energy sources, contributing to population growth, are dependent on high quality energy supplies. It is mostly due to several challenging socio-economic reasons. These challenges include enhancement in public health, medical developments, improved food availability and agricultural production, sanitation and hygiene, extension of cultivation, and development of trade and transportation etc. with the same view of supporting the increase in population. Paul Chefurka explained in his study that the overall growth in our energy supply has enabled human population growth.[191]

According to Zabel population exhibit long-term equilibrium as the earth reaches or nears its carrying capacity which reduces pressure on the carrying capacity. Though within a society, at times, very infrequent and brief though, this pressure results into new technological or organisational shifts. These swings continually supplemented by commercialisation and addition of a new and higher quality source of energy. Thus, it is the manipulation and additions of new, advanced quality sources of energy that makes these shifts possible as it

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[189]Energy Information Administration (EIA), *International Energy Outlook 2017*, (Washington, D.C: Office of Energy Analysis, 2017)

[190]Graham Zabel, "Peak people: The Interrelationship between Population Growth and Energy Resources", *Energy Bulletin*, Vol. 20, (2009)

[191]Paul Chefurka, "World Energy and Population: Trends to 2100", 2007, Available At http://www.paulchefurka.ca/WEAP/WEAP.html Access on 19-10-2018

raises the Earth's Carrying Capacity.[192] The exogenous impact of population on energy demand/consumption can be well established from the above discussion. However, interestingly, the consumption of energy and growth of population is "a dialectical pair each transmuting the other, and each being the effect when the other is the cause", according to view point of various scholars. Most importantly, there is adverse effect of increased usage of energy per capita on the population growth rate. In their significant report, "Energy as an Instrument for Socio-Economic Development" Goldemberg and Johansson established that the rate of population growth systematically decreases with growing annual use of energy per capita.

In 26 years, Pakistan's population is doubled from 65 million in 1972 to 130 million in 1998. The population expansion has come with extraordinary growth in domestic demand for electricity. Urbanisation is yet another significant wonder associated with population and economic growth for instance, the transferal of the work force from rural agricultural area to urban industrial area, or gradual important conversion of rural sector into urban sector. With both, consumption of energy gets affected considerably in multiple ways. According to International Energy Agency, 67.77% of world energy is exploited by the residents of big city residents. From 25.5% of total population in 1972 to 36.4% in 2017, there is almost 46% increased growth in urban population in Pakistan. With different things being equivalent, an aggregate statistical evidence suggests that, a 10%rise in the population of urban sector would proliferate modern energy usage per capita by 4.5% or by 4.8%/ $ GDP.[193]

While revising the multivariate consumption of energy in Pakistan and the growth of population for 36 years from 1976 to 2010, Khalid Zaman et al. have conferred key factors of energy usage based on the direct foreign investment, income and the growth of population.[194] With these he also demonstrates that all these elements have constructive connection with the consumption of energy in Pakistan. Apart from the sheer size, stationary utility such as heating, lighting, washing, cooking and other household consume a large amount of domestic

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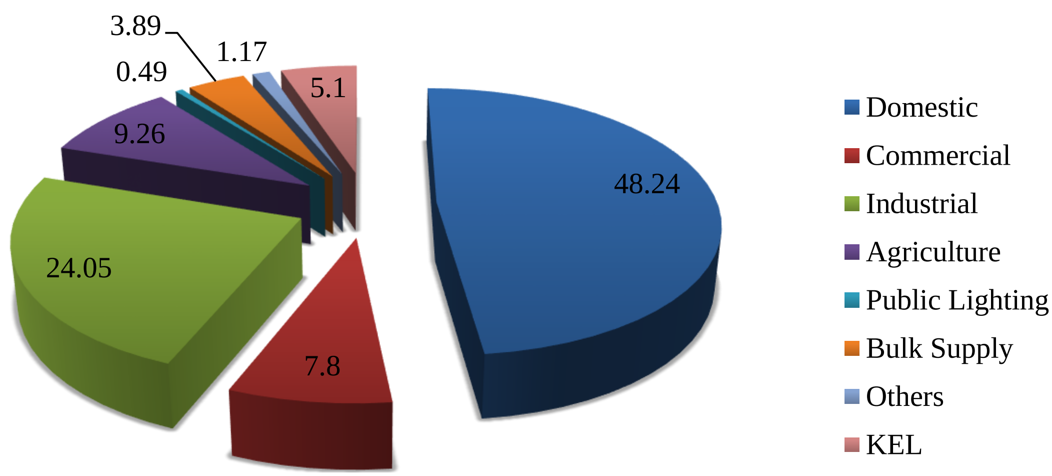
[192]Graham Zabel, "Population and Energy", (2000), Available At: https://www.dieoff.org/ Access On 19-10-18

[193]Donald W. Jones, "How Urbanization Affects Energy-Use in Developing Countries", *Energy Policy*, Vol. 19, No. 7, (1991), pp. 621-630

[194]Zaman, et al, "Determinants of Electricity Consumption Function in Pakistan: Old Wine in A New Bottle", *Energy Policy*, Vol. 50, pp. 623-634

energy, population factor in Pakistan counts more towards increased energy consumption, particularly electricity. This is well discovered by a study conducted by Lubna Hameed, and Dr Asad Ali Khan while examining the effect of population growth on the consumption of energy in Bahawalpur City of Pakistan. The results indicated substantial constructive connection among the growth of population and immense rise in electronic machines, as the demand of domestic energy is driven as much by possession of energy-consuming effects as by their consumption, causing a surge in domestic energy consumption.[195] Based on the latest NEPRA statistics, Figure 3.2 below shows almost 50% share of domestic consumption in the overall energy consumption in Pakistan.

**Figure 3.2: Sectoral Consumption of Electricity in Pakistan**




Pakistan's population is surpassing its energy infrastructure, most specifically electricity. In order to raise the living standards there is a need for introducing a corresponding increase in magnitude of energy and energy-efficient technologies. In early 1987, José Goldemberg et al. in their seminal work, "Energy for a Sustainable World" concluded that with best available energy-efficient technologies, a mere 10% rise in amount of energy provided to the population of developing countries will raise their living standards

[195]Lubna Hameed, and Asad Ali Khan, "Population Growth and Increase in Domestic Electricity Consumption in Pakistan: A Case Study of Bahawalpur City", *The Explorer Islamabad*, Vol. 2, No.1, (2016), pp. 27-33

as higher as attained in Western Europe in the 1970s.[196] As demonstrated by Goldemberg and Thompson, the population growth rate will also retard from increased energy consumption per capita. With special reference to the rural areas, this rise in the consumption of energy can be in the form of directed energy intervention.

In the late 18th century, the Industrial Revolution, closely followed by great competition for access to and control of energy resources by the major powers, established the infallibility of energy for economic growth of societies. However, at academic and, even, at governments level there was no sustained debate or attempt to objectively study the nexus among the consumption of energy and socio-economic progress. While suggesting a close connection among per capita energy usage and per capita income, Alan M. Strout, then a Research Affiliate with Massachusetts Institute of Technology's Energy Laboratory, deplored in as late as 1977 the lack of awareness the communication among the consumption of energy and growth of economy in Central America. He remarked, "As yet there seems to be little attentiveness within the region of the role of fuel and energy in growth of economy, nor do governments display much sense of determination in re-evaluating their supply of energy and demand situation in an inclusive and protracted manner".[197]

The research and innumerable pragmatic studies on the consumption of energy and growth nexus most specifically the electricity as it is the most resilient form of energy required to constitute the infrastructure of both social and economic development. However, till to date, the consensus on the direction of connection among the consumption of energy and growth of economy remains insubstantial as study yielded mixed results. According to renowned scholars there is unidirectional fundamental connection among growth of economy and the consumption of energy, while in the point of view of other scholars the relationship is bidirectional. However, still, few scholars discover no substantial fundamental connection among the consumption of energy and GDP growth. Primarily due to heterogeneity in climate situations, changing energy usage patterns, the construction and phases of economic development in a country, there is a fundamental discrepancy in conclusion of the studies.

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[196]Jose Goldemberg, et al., *Energy for a Sustainable World* (Washington, DC: World Resources Institute, 1987)
[197]Alan M. Strout, "Energy and Economic Growth in Central America", *Annual Review of Energy*, Vol. 2, (1977), pp. 291-305

Four reciprocally exclusive assumptions are thus yielded from these along with many other empirical studies with diverse and often diverse results. The results are amalgamated by the comprehensive study of Apergis and Payne, it denotes, the growth proposition with unidirectional causality from the consumption of energy to the growth of economy; the conservation proposition having unidirectional connection from the growth of economy to the consumption of economy; the feedback proposition postulating interdependent bidirectional causality among the consumption of energy and the growth of economy; and the neutrality proposition suggesting the absence of a fundamental connection among consumption of energy and growth of economy.[198]

**The Growth Proposition:** In order to enhance labour and capital in production and to attain economic, social, and technological development, this proposition hence concurrences a central role to consumption of energy in the growth of economy of a nation. An increased energy production will contribute equally directly as well as indirectly, to a growth in real GDP as if the causality flow from energy consumption to economy is positive. Any policies or attempts, in this case, to reduce energy consumption will lead to a slowdown of economy and retard real GDP, as the economy is dependent on energy. However, if, for instance, an increase in demands of economy decrease in the energy consumption as production moves toward less energy concentrated service sectors, a rise in energy consumption may not unavoidably lead to rise in real GDP, or may even adversely affect it. Furthermore, excessive consumption of energy in non-productive zones of economy, an inefficient supply of energy or capacity restraints, could attribute towards adverse effect of the consumption of energy on real GDP. Nachane et al, in a multi-country study, over the period 1950 to 1985, employ Engle-Granger Bivariate Error Correction Models in specific study on Guatemala with unidirectional causality, to seek support for the growth proposition from the consumption of commercial energy per capita to real GDP per capita.[199]

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[198]James E. Payne, "A survey of The Electricity Consumption-Growth Literature," *Applied Energy*, Vol. 87, No. 3, (2010), pp. 723-731

[199]Dilip M. Nachane, Ramesh M. Nadkarni, and Ajith V. Karnik, "Cointegration and Causality Testing of the Energy-GDP Relationship: A Cross-Country Study", *Applied Economics*, Vol. 20 (1988), pp. 1511-1531

**The Conservation Proposition**: From the results of this proposition, it hypothesizes that increased economic growth prompts increased energy consumption. It spikes that due to increase in real GDP, there is rise in industrial manufacture of goods and services in the form of basic amenities and luxury items, which thus lead to increased energy consumption. In this specific case, environmental policies for energy conservation and waste reduction will not affect, at least eloquently, the economy, as the causality flows from real GDP to the consumption of energy. However, there might be instances where a developing economy is compelled by infrastructural, political, generating inefficiencies or mismanagement of resources, and the diminution in the demand for goods and services, including consumption of energy.[200] On the other hand, a developing economy may depend progressively on more energy efficient technologies and less energy intensive services, from which arise in growth of economy would have an inimical implication on consumption of energy. Murray and Nan provided evidence in a multi-country study on energy consumption and economic growth, which is supportive of the conservation proposition as real GDP Granger-causes energy consumption in El Salvador during the years 1970 to 1990.[201] Similarly it is substantiated for the conservation proposition, in specific examination of the causal relationship between energy consumption per capita and real GDP per capita for more than hundred countries during the years 1971 to 2000, in the cases of Costa Rica, El Salvador, and Panama, whereas, the results for Honduras and Nicaragua are indicative of the neutrality proposition.

**The Neutrality Proposition**: This proposition disavows some fundamental connection among the consumption of energy and economy, while considering consumption of energy a small fraction of overall inclusive output with the minor effect on real GDP. Putting differently, consumption of energy and real output may not have any substantial or noteworthy connection. As energy consumption, particularly electricity, indicates too small of a proportion of a country's gross domestic product, this proposition emanates from the fact that the consumption of energy should not impact the growth of economy. In the same manner in conservation proposition, as environmental and energy preservation policies would not negatively affect real GDP, so these arrangements could be pursued more dynamically. Huang

[200]Jay Squalli, "Electricity Consumption and Economic Growth: Bounds and Causality Analyses of OPEC Countries", *Energy Economics*, Vol. 29, (2007), pp. 1192-1205.

[201]Donald A. Murry, and Gehuang D. Nan, "A Definition of the Gross Domestic Product-Electrification Interrelationship", *The Journal of Energy and Development*, Vol. 19, No. 2, (1994), pp. 275-283

et al. by using sing a Dynamic Panel Model for eighty-two countries of fluctuating the levels of income during the time period of 1972–2002, provide a substantial provision for the neutrality proposition for the low-income panel while endorse the preservation proposition for the middle-income panel.[202]

**The Feedback Proposition:** The feedback proposition finally recommends that the consumption of energy and real GDP are interconnected and can accommodate as adjuncts to each other. As advocated by this proposition, there is a duplex fundamental connection among the consumption of energy and real GDP. So, in this specific case, the real GDP would not get affected by the policy of energy adopted to improve the efficiency of the consumption of energy.

Several studies conducted in Pakistan have, as elsewhere, delivered no clear connection among the consumption of energy, particularly electricity, and socio-economic growth. Whereas, various scholars find a strong relationship between the two, the causality itself and its flow remain argumentative.

Syed Ali Raza et al., confirm a valid long-term connection among consumption of energy and the growth of economy in South Asia, with unidirectional fundamental connection running from the consumption of energy to the growth of economy, after using annual data from year 1980 to 2010 in in four South Asian countries, namely Pakistan, India, Bangladesh and Sri Lanka.[203]

In 1996, Masih and Masih conducted the first study to test for co-integration among total consumption of energy and the real income in Pakistan, along with five other Asian countries. As they found connection from the consumption of energy to the growth of economy in India, it was the reverse for Indonesia. The causality established was bidirectional

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[202]Bwo-Nung Huang, Ming Jeng Hwang, and Chin Wei Yang, "Causal Relationship between Energy Consumption and GDP Growth Revisited: A Dynamic Panel Data Approach", *Ecological Economics*, Vol. 67, No. 1, (2008), pp. 41-54

[203]Syed Ali Raza, Syed Tehseen Jawaid and Mohammad Haris Siddiqui, "Electricity Consumption and Economic Growth in South Asia", *South Asia Economic Journal*, Vol. 17, No. 2, (2016), pp. 1-16

in the case of Pakistan.[204] This bidirectional fundamental connection among the consumption of energy and the growth of economy was also subsequently supported by other studies, for short as well as for long run periods.

However, this conclusion is contested. After examining the long term connection among real GDP per capita and energy utilization for Pakistan during the time period of 1971 to 2008, Attiya Yasmin Javid et al., located long term causality among real GDP per capita and consumption of energy, with unidirectional causality running from consumption of energy to the growth of economy.[205] Contrariwise, managing from real economic activity to the usage of energy, during the time period of 1960–2008, another empirical analysis, have shown unidirectional causality in commercial and residential sectors by using the data for aggregate series as well as four major categories, namely residential, commercial, agricultural and manufacturing. More specifically in case of Pakistan, this study is of predominant significant, as industrial and transport sectors average major share in energy consumption 36% and 33% respectively with domestic share at 23%, agriculture and commercial 3% each and all others 2%.

This unidirectional causativeness from the growth of economy to the consumption of energy can be anticipated with empirical data. There was a significant increase of 7.3% in industrial sector led to 5.2% per annum increase in energy consumption, specifically during the period 2001/02 to 2009/10. By using data during the years of 1971-2012, other related study discovers increase in energy consumption by 2.4% points at 10%-point growth rate of GDP per capita. Other than the industrial and commercial effects, personal affluence, a corollary of economic growth, energy consumption also devours positive causality effect. All other things being equal, a 1% rise in capital connected with 0.3414% rise in the demand of electricity.[206] Energy is required to use and manufacture the procurement of electric appliances and cars due to increased purchasing energy-induced. In general course, as by their usage, the demand of household electricity is driven as much by possession of energy using

[204]Abul M.M. Masih, Rumi Masih, "Energy Consumption, Real Income and Temporal Causality: Results from a Multi-Country Study Bsed in Cointegration and Error-Correction Modelling Techniques", *Energy Economics*, Vol. 18, No. 3, (1996), pp. 165-183

[205]Attiya Yasmin Javid, Muhammad Javid, and Zahid Ashraf Awan, "Electricity Consumption and Economic Growth: Evidence from Pakistan," *Economics and Business Letters*, Vol. 2, No. 1, (2013), pp. 21-32

[206]Muhammad Ahahbaz, A.R Chaudhary, and Ilham Ozturk, "Does Urbanization Cause Increasing Energy Demand in Pakistan? Empirical Evidence from STIRPAT Model", *Energy*, Vol. 122, (2017), pp. 83-93

assets. With improved socio-economic status of the country, electricity, being the most widely used form of energy, has shown immense growth in consumption. In respect to it, an increase takes place progressively from 23% during 1980-81 to almost 46.5% in 2010-11and 48.24% in 2017 as the share of Pakistani domestic consumers in total energy consumption.[207]

There are far-reaching implications from above conducted studies and conclusions. In Pakistan, from the year 2005 to 2008, the 8-9% of annual GDP growth came with corresponding commercial energy consumption with increase of about 8.4% annually, with highest increase in the industrial and commercial sectors at 12.5% and 11.3% respectively. It is also followed by 5.7% increase in residential and agriculture sectors. Energy consumption experienced an annual increase of 11.6% in commercial activities, 7.4% and 5.1% in residential and industrial sectors, and 7.1% in agriculture.[208] Though in Pakistan, the energy system as a whole did not witness a conforming improvement which, persisting even in 2019, has led to the wickedest sort of energy crisis and prolonged energy outages.

**Table 3.2 Magnitude of Demand and Supply Gap**

| Year | Demand and Supply Gap |
|---|---|
| 2011 | 7,000MW |
| 2012 | 6,000MW |
| 2013 | 5,000MW |
| 2014 | 7,000MW |
| 2015 | 6,000MW |
| 2016 | 4,000MW |
| 2017 | 7,000MW |
| 2018 | 7,000MW |

**Source:** Kamal A. Munir and Salman Khalid, "Pakistan's Energy Crisis: How Did We Get Here?", *The Lahore Journal of Economics*, Vol. 17, (September 2012), p. 73

On the contrary, the energy becomes a constraining element to the growth of economy and insufficient energy supply will negatively affect economy, as if the causality flows from usage of energy to the growth of economy. This may explain steep slowing down of economy in post-2008 when energy deficit inclined 6000 MW on average (See Table 3.2).

[207]NEPRA, State *of Industry Report 2017* (Islamabad: NEPRA, 2018)

[208]Rashid Aziz and Munawar Baseer Ahmad, *Pakistan's Power Crisis: The Way Forward* (US Institute of Peace: 2015)

## II Global Climate Change Impact on Pakistan and Energy Crisis

In the international climate system Pakistan is found one of the top 10 climatic vulnerable country (See Table 3.3) The study carried out involves a key element which is the global climate change impact i.e., 'rising temperature'. It accepts it as a factor of "rising energy demand" in Pakistan, specifically South Punjab as sample. Existed literature associated to climate change envelopes various angles, such as, impact on cotton productivity, natural disasters, which have broad implications on Pakistan. Several significant impacts of all indicators of energy are also examined in an extended literature available which covers the relationship between climate change and energy demand. It mainly includes the indicators like, how changing rate of precipitation and droughts is affecting reliability of hydro energy, and how natural disasters like floods can affect energy transmission and distribution lines etc. However, the energy demand in South Punjab region has now provoked, as this research promptly attempts to exhibit how temperature is rising in region.

**Table 3.3: Global Climate Risk Index 2017** 10 Most Affected Countries Due To Climate Change. (1996-2015)

| Country | CRI Rank |
|---|---|
| Honduras | 1st |
| Myanmar | 2nd |
| Haiti | 3rd |
| Nicaragua and **India** | **4th** |
| Vanuatu | 5th |
| **Bangladesh** | **6th** |
| **Pakistan** | **7th** |
| Vietnam, Madagascar, | 8th |
| Guatemala | 9th |
| Chile | 10th |

**Source:** David Eckstein, Vera Kunzel and Laura Schafer, "Global Climate Risk Index 2017," German Watch. November 2017.

Rise in global temperature is mainly because of the industrial activities that release carbon dioxide in atmosphere. Notwithstanding, the World Meteorological Organization (WMO) began to understand that human activities were antagonistically affecting the temperature of Earth. Scientists and researchers in 1980's further started to consider that these climate changes are serious issue, specifically when intense heat waves and drought strike

North America in 1988. This specific episode sketched political attention and as a result WMO and United Nation Environment Programme (UNEP) shaped International Panel on Climate Change (IPCC). The main task allotted to IPCC was to investigate and report with the scientific proof on continuous changes on climate.

The overall climate around the globe all together is represented as Earth's climate which is continuously changing over the time. If someone consider the overall Earth's climate, he will notice that there have been times when it was warmer and there have been times when it was cooler, respectively at present. However, this change in climate takes a considerable span of time, maybe hundreds or even millions of years. According to the history of climate change, the earth's temperature is continuously rising since 20$^{th}$ century. This agonizing change in climate has severe, pervasive and irresistible impact on the population of world. Previously, this topic was debated only within scientific society. However now, it is considered as public agenda. Various climate change organization have distinct it and its rationales in different manners as mentioned below.

The U.S. Environmental Protection Agency (EPA), the National Aeronautics and Space Administration (NASA), and the National Oceanic and Atmospheric Administration (NOAA) orchestrate on the idea that, climate change is surely a reality which is in certain brought about by human activities on this earth. An accord among the scientists establishes that the present change of climate is only because of human activities. This is extensively ascribed that carbon dioxide and other greenhouse gases which are released in the environment is mainly because of utilization of fossil fuel. Rise in temperature and sea levels are caused by these gases which entrap heat. However, Intergovernmental Panel for Climate Change (IPCC) expresses that the climate change also includes change with respect to natural volatility in parallel with human activities.

As per NASA, climate change is an extensive scope of world-wide phenomenon made overwhelmingly by burning fossil fuels, which increases heat-trapping gases to the atmosphere of earth. These circumstances additionally envelop changes such as ice mass loss in Greenland, sea level rise, Antarctica, Arctic and mountain glaciers globally, shifts in

flower/plant blooming, and extreme weather events, which incorporates increase temperature patterns depicted by perilous global warming.

With adverse effect of climate change, every region in the world is aggrieved. Among all, the most vulnerable countries are of African and Asian region, as these countries accommodates around already undernourished 850 million people. By 2050, it is assessed that around 600 million people become water stressed in Africa would. Moreover, by 2050 it is expected that agricultural production will be decreased by 50%, as Asia has regularly suffered from floods. In the Arab spring, the changes in climate are characterized as a stress factor as well. The crop yield will decrease and the food prices will increase when dry regions will get drier and wet ones get wetter. This will prompt to the regional turmoil and political instability.

While having a portion of just around 0.8% of entire global GHG productions, Pakistan positioned at 135$^{th}$ number due its minor contribution in Greenhouse Gases. Unfortunately, Pakistan is most exposed country towards the adverse impact of climate change. The two main rainy seasons of Pakistan are winter and summer. As per the stats of Climate Research Unit (CRU), the amount of rainfall has increased by 60 mm over the past 109 year. There has not been a striking change as far as its quantitative impact. However, Pakistan has experienced from continuous dry and wet spells in recent decades which exhibit the effect of global climate change.[209] Pakistan has experienced changing precipitation pattern, droughts, and intense heat waves, as there are variations in hydrological cycle which have become inevitable. In order to understand its effects on rising energy demand, a definite depiction of manifestations of climate change is needed which are added below:

Manifestations and Repercussions of Climate Change: Climate Change is expressed in various forms, called indicators. These indicators essentially provide understanding of changing environmental conditions which are used to measure climate change. In regards with further assistance in planning and resiliency for climate impacts, these indicators also assist in assessing the potential risks and vulnerabilities. There is an increase in average temperature of atmosphere over land which has affected the crops, caused wild fires and droughts. Heat that

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[209]Ghulam Rasul, "Climate Change in Pakistan Focused on Sindh Province", *Pakistan Meteorological Department*, Technical Report No.PMD-25, (December 2012)

radiates from the Earth’s surface is being absorbed by Greenhouse gases. Due to human activities, these gases have increased dramatically, including the use of fossil fuels on regular basis. Ultimately are its adverse effects on the lowest layer of earth called troposphere, which is continuously warming and results in high temperature on earth.

The ice caps in the arctic sea melt in summers, as the air temperature above the oceans additionally gets warmer which caused more evaporation and respectively, these ice caps grow in the winters. It is anticipated that the sea might lose all its summer ice till 2100 just because of the rising temperature. The melting of glaciers is a source of water supply for numerous people. However, when the glaciers lose its mass the deficiencies are clearly seen in numerous regions. Despite that, the mass of these glaciers remains balanced, if there is no climate change anywhere around the world. The balance is kept up when the melting ice in the summers is supplanted by snowfall in winters. There is a catalyst effect of global warming on the melting process of glacier ice and seasonal snow, as it causes more water accumulation in the sea discharges when contrasted with normal. The snow in the northern hemisphere is contracting. In process of keeping the earth climate cool, snow plays a significant role. It controls the amount of heat absorbed by Earth and reflects this excessive energy back to Sun. The planet is now absorbing more solar energy which is resulting in increase in overall temperature because of massive loss of ice in past 30 years. When water temperature rises and glaciers melt, it results in expansion of ocean, so this melting of glacier is causing rise in sea level. The threat of floods is also increasing. Humidity Ocean Heat Content is increasing: Heat is re-established and discharged by the oceans as it is a characteristic phenomenon and it helps in stabilising the climate. Furthermore, the marine life is also getting affected due to rise in the level of sea and melting glaciers. Right at the moment when the ice present in the ocean melts, the snow melts even more when the sunlight is absorbed once again. At the point when sea gets hotter, they expel heat in the environment as well. This consequently prompts tropical cyclones and hurricanes. Moreover one-third of the carbon dioxide emissions is making water progressively acidic as it eventually arrives at the oceans. Oceans are now absorbing 90% more heat which has caused them to become 40% more acidic than ever before.

Climate change has across the board suggestions on practically all circles of life, alongside the entirety of its manifestations which are mentioned above. The changes in

climate have incredibly influenced the agriculture sector. It has gotten extremely difficult for ranchers to modify with the startling changes in climate conditions alongside with unpredictable water shortages. There is a reduction in the overall production of crops nowadays as they are widely attacked by weeds, diseases and pests. Similarly, the climate change has also affected health sector. Because of the high degree of pollution, a huge increment in the level of smog has hit Pakistan. Lungs are directly got affected which may lead to asthma. According to various reports, numerous deaths have happened due to the extreme level of heat wave across the country. The modes of communication infrastructure will heavily disrupt in case of any disastrous circumstances. For instance, roads get blocked at the time of floods and electricity supplies are also got disturbed at times of heavy rain and storm. Climate changes have also disturbed animals' wildlife. For instance, due to loss of sea ice, polar bears which are among endangered species, struggle to survive. Furthermore, with even a modest change in temperature of ocean, coral reefs are additionally got affected. Their devastation further makes different species fall too, as they are a source of home for many other species.

Changes in climate widely affected the Energy sector as well. In fact, Energy and climate impact each other as both are connected to each other. While applying ESI on Pakistan's energy security in chapter 1, the indicator of sustainability affects the energy on climate change which has been discussed. Whereas, the effects of climate change on energy have been discussed by the indicator of natural catastrophe from different aspects. Specifically, at this point, the effects are taken into consideration for rising temperature on energy demand. Firstly, with the help of relevant scholarly research, positive connection among temperature and the demand of energy is discussed below and then qualitatively the rise in both entities in Pakistan's perspective is given.

**Positive Relationship between Rising Temperature and Rising Energy Demand**

Due to the increase in global temperature, demand for energy is increasing as per the national and international studies. In 2050, it is estimated that the use of air-conditioner for

residential purpose only will increase from 300 TWh to 2000 - 4000 TWh.[210] However in cold weather, the demand for heating would ascend likewise. This change in temperature imposes high weight in peak hours of energy demand along with the consumption will further disturbs the energy supply framework which builds the demand of energy for warming and cooling purposes. As indicated by the regional geographical differences, the level of effect fluctuates from nation to nation. For example, regions with an impressively warmer atmosphere will require greater energy for cooling purposes though regions with cold atmosphere will in general have an expansion sought after for heating effect. In this way, energy consumption and increased temperature have a positive relationship exists between them. However, different factors also have an influence on the level of changes in consumption pattern, which includes the fuel mix structure, income level and economic status of the country. The flexibility of energy demand to temperature in this manner fluctuates among developed and developing countries.

In the perspective of Pakistan, the findings and recommendations of the World Bank Group in its research report are quite relevant and supportive of positive relationship between temperature and energy demand. According to the study of this report, South Asia is profoundly vulnerable to the continuous climate changes across the globe.[211] In this region, it is even more difficult to address this situation as it also suffers from poverty. It is essential to these countries to figure out how to determine these issues, so as to endure the present-day challenges. To formulate appropriate climate change Action Plans and strategies in this regard, it is essential that South Asian countries become acquainted with the threats postured by changing climate. Paris agreement has been signed by various countries. Those countries have also submitted their 'Intended nationally determined contribution' (INDC) which specify that these nations are as of now circumspect towards the imminent catastrophes that may tag along climate changes. With the specific focused on the adverse impacts of climate change on

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210 Carolyn Symon, Richard Black, "Climate Change: Implications for the Energy Sector", *University of Cambridge/World Energy Council*. (2014). Available At https://www.worldenergy.org/wp-content/uploads/2014/06/Climate-Change-Implications-for-the-Energy-Sector-Summary-from-IPCC-AR5-2014-Full-report.pdf Access On: 28-11-18

211 Muthukumara Mani, et al., "South Asia's Hotspots: The Impact of Temperature and Precipitation Changes on Living Standards", (2018). Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/28723/9781464811555.pdf?sequence=5&isAllowed=y Access On 28-11-2018

living standards predominantly at district level, this report recognizes the "hotspots" of South Asia. The rising temperatures have an upward trend as per the stats of last 60 years. Even a 1-degree centigrade increase in temperature could make noteworthy transformation as the temperature is main driving force with having diverse impacts. In order to discover the consumption expenditure pattern of households at district level, this report analyses historic data along with rough data on rising temperature and precipitation. The report for the most part focuses on the main concern of how climate change will influence the consumption expenditures of household. The recommendations from this study provide countries to adopt more climate friendly strategies in order to lessen the grave challenge of climate change. To help these regions to become resilient by providing weather forecast, climate risk assessment and other adaption measures, the public sector can assume an imperative role. As there are different sets of actions for each area, it worries upon the fact that no single policy framework can applied to all regions. To reduce the climatic burden for each country, this study likewise proposes that what measures can be taken in a range of 20 to 50 years. For example, India should create more non-agricultural jobs and control over water crisis. However, Pakistan should focus on improving access to energy. The report stresses for Pakistan to improve energy access which is a clear indication of positive relationship between temperature and energy, despite the fact it analyses the effects of rising temperature on the living standard.

**A. Rising Temperature in Pakistan:** Rising temperature is the most significant indicators of climate change among all others. The reason behind the selection of temperature as an indicator here apart from other manifestations of climate change mentioned above, including precipitation, humidity, and cloud cover, is the energy demand which is most responsive and sensitive to fluctuations in temperature.[212] However, the rise in global temperature was triggered at an accelerated rate during the era of industrialization. In contrast to 1990's and 1980's, in 21$^{st}$ century highest temperatures were recorded as 9 out of 16 warmest years ever recorded on the global level were from 21st century. Year 2010 was set apart as the warmest year ever with record increase of +0.53°C regardless from the range term average. There has been a rise of 0.74°C in global temperature from the year 1906 to 2005.

[212]Rafat Mahmood, Sundus Saleemi and Sajid Amin, "Impacts of Climate Change on Electricity: A Case Study of Pakistan", *The Pakistan Development Review,* Vol. 55, No. 1, (2016), pp. 29-47

Polar Regions became considerably warmer due to rise of 17 cm in the sea level. According to scientists, the global-average surface temperature might increase by 2°C-4.5°C in 21st century, followed by the universal mean temperature that is likely to increase by at least 1.5°C by 2050. However, as compared to the marine stations, the large urban areas are marked by annual temperature increase at a higher rate.

As per report of IPCC of year 2007, increasing surface air temperature considered as the main indicator of climate change in Asia. Asia has observed the increases in surface air temperature to be less than 1°Cand 3°C. Pakistan is blessed with diverse climatic conditions. It possesses frozen ice tops in North while warmer deserts in the South. The mountains in North structures a barrier from cold waves which enter in South during winter and secure the North from monsoon rains too. Whereas, the summer monsoon brought by Arabian Sea in Southern border is cherished by moisture. However, due to changes in climatic conditions, Pakistan has also been distressed. As per the study which applied Global Climate Models (GCM) and Regional Climate Model (RCM), in Asia, the average air temperature is raised by 2.9°C. According to stats of the last 40 years, annual average temperature of Pakistan is raised by 0.76°C. The country has a rising trend towards annual mean surface temperature since the beginning of 20th century. The city of Pakistan, namely Mohenjo-Daro, was recorded the hottest ever temperature in Asia. In 2010, the temperature was reached to 53.3°C in twelve cities of a country which has been recorded as the fourth highest temperature. Eighteen individuals died due to an outcome of this outrageous temperature. By the year 2100, among the vulnerable regions, it has been predicted that Pakistan will encounter with a rise of 4 to 6°C in temperature with 0.5° Caverage rise per decade.[213]

Annual mean temperature in Pakistan has risen during a period of last 5 decades by almost 0.5°C. Each year, days of heat waves have also raised by 5 times in the past 3 decades. Annual mean temperature in the country is likely to increase from 3 to 5 degree centigrade in 21st century. Year 1998 was the warmest year ever logged at global level. In Pakistan, year 1941 was recorded as the warmest year in 20th century. As per the figures provided by CRV,

[213]Sara Del Rio and M. Anjum Iqbal, "Recent Mean Temperature Trends in Pakistan and Links with Teleconnection Patterns", *International Journal of Climatology,* Vol. 33, No. 2, (2013), pp. 277-290

from the year 1901 to 1937, the tendency of 10 years of average temperature peculiarity of Pakistan shows a warming trend of a country. However, a significant increase in the temperature has been observed during 1988 to 1948. While cooling trend in the temperature has observed in year 1970, as no sharp changes in the temperature were noted from the year 1970 to 1998 and it stayed normal. However, according to Pakistan Meteorological Department (PMD), from the year 1998 onwards a continuous increase in the temperature was recorded. In 20th Century, in span of every 10 years, the temperature was increased by 0.057°C.[214] With these effects of the changing climatic conditions, Pakistan is considered as a vulnerable region.

The province of Punjab is of incredible importance having 60% of the total population of the country. It likewise contributes 55% of the total agricultural production. The area to observe climate change trends in this study is specific to South Punjab, with main focus on sample cities including D.G. Khan, Hasilpurlh, and Bakhar. Weather conditions in these three cities along with energy situation are given below.

Khanewal: For a long period of time, the summers in Khanewal are generally extreme hot, moist and clear. However, throughout the year winters are comparatively short, cool, and mostly clear and remained dry. The temperature ordinarily shifts from 47°F to 108°F and is infrequently underneath 41°F or above 114°F along the year. Four months, from April 26 to August 26, with an average daily high temperature above 100°F, are considered as hot season. June 5with an average high of 108°F and low of 86°F is considered as hottest day of the year. The season starts from December 4 to February 23, remains for 2.7 months, with an average daily high temperature below 77°F is considered as the coolest period. January 9, with an average low of 47°F and high of 69°F is the coldest day of the year. From April 19 to July 18, an average daily incident shortwave energy per square meter is above 7.1 kWh which is considered as brighter period of the year and it lasts for 3.0 months. May 27 is the brightest day of the year, with an average of 7.9 kWh. The darker period of the year rests from November 9 to February 5, with an average incident shortwave energy per square meter below 4.4 kWh. With an average of

[214]Qamar-uz-Zaman Ch. et al., "Climate Change Indicators of Pakistan", *Pakistan Meteorological Department*, Report no. PMD 22/2009, (2009)

3.6 kWh December 21, is the darkest day of the year. In Khanewal, the length of the day fluctuates fundamentally through the span of the year. In 2018, December 22, with 10 hours, 13 minutes of daylight is the shortest day and with 14 hours, 5 minutes of daylight of June 210, is the longest day.

Burewala: the winters are short, cool, dry, and for the most part clear and the summers are long, sweltering, humid, and clear in Burewala. The temperature gets hardly below 38°F or above 112° F and usually varies from 43°F to 105°F throughout the span of year. To visit Burewala for hot-weather activities, mid-September to mid-October is considered as the best time of year. The hot season with an average daily high Temperature above 97°F, rests for 4.4 months starting from April 29 to September 10 in Burewala. June 13 is the hottest day of the year with an average high of 105°F and low of 82°F. The cool season with an average daily high temperature below 74°F, remains for 2.9 month starting from December 1 to February 25. January 8, with an average low of 43°F and high of 66°F is the coldest day of the year. In Burewala, the length of the day fluctuates fundamentally through the course of the year. December 22 with 10 hours, 5 minutes of daylight, was the shortest day in year 2018 and June 21with 14 hours, 13 minutes of daylight was the longest day. The brighter period of the year rests for 3.1 months with an average incident shortwave energy per square meter above 7.0 kWh, starting from April 22 to July 26. June 1 with an average of 8.0 kWh, was the brightest day of the year. The period with an average incident shortwave energy per square meter below 4.2 kWh, starting from November 7 to February 8 remains for 3.0 months was the darker period of the year. With an average of 3.3 kWh, December 22 was darkest day of the year.

Hasilpurlh: Hasilpurlh has exceptionally very hot and prolonged summers while winters last for a shorter period of time which is cool and mostly clear while remains dry for rest of the year. Overtime, the temperature in general lies between 45°F to 106°F and hardly got lower 40°F or higher than 113°F. From April 28 to September 9, the hot season remains for almost 4.4 months with the average high temperature of above 99°Fdaily. With an average high of 106°F and low of 85°F, 12$^{th}$ June was recorded as the hottest day of the year. However, winters starting from December 2 to February 24, last for 2.8 months with

the average high temperature kept below 75°F. 9th January, with an average low of 45°F and high of 67°F was recorded as the coldest day of the year. Throughout the span of year, the average occurrence on daily basis of shortwave solar energy goes through major seasonal deviation. The time which continues from April 21 to July 25 is considered as the brightest period. Relating to that the average incident shortwave energy per square meter stays above 7.0 kWh. As per the records the brightest day of the year is June 1 with having an average of 7.9 kWh. The time starting from November 8 to February 7 in which an average incident shortwave energy per square meter goes below 4.3 KWh is considered as the darkest period. With an average of 3.4 kWh, December 22 recorded as darkest day of the year. Throughout the span of the year, time range of the day in Hasilpurlh changes immeasurably. In 2018, with 10 hours, 8 minutes of daylight, shortest day was predicted to be December 22. Whereas, June 21 with 14 hours, 10 minutes of daylight was the longest day. Based on a statistical analysis of historical hourly weather reports and model reconstructions, this report illustrates the standard weather in Hasilpurlh from January 1, 1980 to December 31, 2016.

**B. Rising Energy Demand in Pakistan:** Energy demand denotes the required amount of energy for a particular time. It is broadly mistaken with energy consumption, as consumption refers to the volume of energy used over a given timeframe. It is measured in terms of "KWH" i.e., the required amount of energy multiplied by the number of consumption hours. However, if exact energy demand data is not easily available then analysis on energy demand is undertaken on energy consumption data. During the years 2006-2016, 1.7% growth rate is noticed in global energy consumption. According to the factual data on Pakistan, the energy demand is continuously rising in different sectors, as given below in tables on energy consumption.[215]

[215] "British Petroleum (BP) Statistical Review of World Energy 2018", 67th Edition (2018), Available At https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf Access On: 10-01-2019

Climate change, population growth and maladies in energy governance are significant reasons to cause energy crisis in Pakistan. Since it affects demand for cooling or heating, the domestic demand is most responsive to changes in climate. Unlikely industrial energy consumption is less affected by climate change. Moreover, population growth is legitimately connected with domestic energy consumption (See Table 3.4).

**Table 3.4: Energy Consumption in Pakistan in Different Sectors**

| **Sectors** | **Energy Consumption (%) 1984-85 Total: 18 Billion kWh** | **Energy Consumption (%) 2016-17 Total: 96 Billion kWh** |
|---|---|---|
| Agriculture | 15.9% | 9.7% |
| Industrial | 35.5% | 25.1% |
| Commercial | 8.0% | 8.2% |
| Domestic | 28.9% | 51.0% |
| Others | 11.6% | 6.0% |

**Source:** Energy Year Book (2017)

Since the area of this study is specific to South Punjab, thus an area specific data on rising energy demand is also collected and presented here (see table 3.5).

**Table 3.5: Energy Consumption in Punjab Province from (1994-2018)**

| Years | Punjab Province (Unit GWh) | Years | Punjab Province (Unit GWh) |
|---|---|---|---|
| 1994-95 | 23,635 | 2006-07 | 45,294 |
| 1995-96 | 24,555 | 2007-08 | 45,040 |
| 1996-97 | 25,121 | 2008-09 | 43,465 |
| 1997-98 | 25,638 | 2009-10 | 45,906 |
| 1998-99 | 25,244 | 2010-11 | 47,638 |
| 1999-00 | 27,033 | 2011-12 | 46,981 |
| 2000-01 | 28,797 | 2012-13 | 46,467 |
| 2001-02 | 30,565 | 2013-14 | 52,088 |
| 2002-03 | 32,328 | 2014-15 | 53,249 |
| 2003-04 | 35,374 | 2015-16 | 57,245 |
| 2004-05 | 37,696 | 2016-17 | 60,940 |
| 2005-06 | 42,018 | | |

**Source:** Energy Year Book 2017

Climate change needs consideration at governmental level as it has proven a factor of energy crisis in Pakistan. Before the Paris Summit, Pakistan has submitted its Intended Nationally Determined Contributions (INDCs) to the United Nations Framework Convention on Climate Change (UNFCC) which is to be taken to account in 2020. Due to weak INDCs, Pakistan is criticized with unclear presentation of emissions reduction and inability to point out impacts of climate change in particular.

## III Maladies in the Energy Governance of Pakistan and Energy Crisis

After getting independence, Pakistan had inherited the conventionally centralized generation system with 60 MW energy generation capabilities (See Table 3.6). During the next twelve years, this capability almost doubled and reached to119 MW. In 1964, energy development grabbed pace and the generation capacity reached 636 MW subsequently after the creation of WAPDA in the same year and the construction of large dams consequential to Indus Basis Treaty. By 1970, in addition to hydel energy units, the installation of some thermal units also increases the generation to 1331 MW, touching 3000 MW by 1980 and 7000 MW in 1990-91. The 1990's saw a prosperous time of thermal generation technology in the form of Independent Energy Plants; however, no major hydro energy projects were initiated. By the end of FY 2017, the installed generation capacity reached 28399 MW as newly introduced renewable sources of energy joined this mix in early 2000's.

**Table 3.6 Evolution of Energy Generation Capacity in Pakistan**

| Year | Capacity (MW) |
|---|---|
| 1947 | 60 |
| 1959 | 119 |
| 1964 | 636 |
| 1980 | 3000 |
| 1990 | 7000 |
| 2017 | 28399 |

**Source**: Azam Amjad Chaudary, "A Panel Data Analysis of Electricity Demand in Pakistan", *The Lahore Journal of Economics*, Vol. 5, (2010), p. 78

The installed generation capacity increased corresponding to the growing energy demand. The government set out on extending energy to far tossed rural areas, the

electrification rate of country increased from 54% in 2006 to 73% in 2016.[216] So the actual generation remained significantly lower due to mal governance, leading to a grid demand-supply gap. The gap between demand and supply can be endorsed to various reasons. One of the most important factors of energy crisis is diminution of domestic fossil fuel. Moreover, overdependence on fossil fuels is not only obstinate, but also steadily increasing, as hydro energy is continuously being ignored. This overdependence on fossil fuels for energy generation, together with other reasons, has led to their fast diminution.

During the years of 1990's, change of government's policy towards energy mix is due to one reason which was the influence of foreign investors. In order to fulfil its energy needs, Pakistan has always been reliant on foreign countries, international organizations and donor agencies. It was in 80's and 90's when World Bank and International Monetary Fund (IMF) offered loans to Pakistan and necessitated to enlarge its markets for external investors.[217] The 1994 energy policy of Pakistan was developed precisely rendering to foreign parameters. Considerable inducements were presented to the independent energy plants (IPPs) along with attraction of private investment worth approximately US $ 5.3 billion which brought 4,100 MW of energy generation capacity to the grid. As the charge of organization of the fuel to the private sector energy generation companies was taken by the government, this expensive oil-based generation mix became a financial constraint on government. Government had to bear high level of losses consequently related to dispatch and long-distance transmission lines. This financial constraint is known as circular debt. There are various other reasons too behind the issue of fluctuations in oil pricing at international level, as it have largely increased the issue of circular debt. The following discussion is about certain maladies referred energy governance.

**Malady of Complex Decision-Making:** Various offices involved in making energy polices is having a very long list which includes distinctive ministries and institutions. Different sectors of energy in the country are being supervised by around 29 different

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[216]International Energy Agency (IEA), *Key Energy Statistics* (Paris: OECD/IEA, 2016), Available At: www.oecd-ilibrary.org/energy/key-world-energy-statistics-2016_key_energ_stat-2016-en Access On 27-02-2019

[217]Dawood, et al., "Impact of International Politics on Pakistan's Energy Crisis", *Developing Country Studies*, Vol. 3, No. 14, (2013), pp. 85-93

organizations. These organizations include Ministry of Water and Power along with its 19-secondary agency, Ministry of Planning and Development with its energy wing, Ministry of Petroleum and Natural Resources and its 16 secondary agencies, Ministry of Urban Affairs, Forestry and Wildlife and Ministry of Food, Agriculture and Livestock deals with biomass. Till the creation of Ministry of Energy in August 2017 with the unification of Ministry of Petroleum and Natural Resources and power wing of WAPDA, dealing with energy had been the primary responsibility of Ministry of Water and Power, while Ministry of Petroleum and Natural Resources managed the energy generation from oil, gas and coal. PAEC managed the Nuclear energy of a country. Mineral Development Cooperation works on exploration and survey of coal. Consequently, this complex organizational setup is illustrated in variety of conflict of interests, lack of preparation, composition and application of energy policies.

Although, energy conservation and management ordinance was also planned with the establishment of national energy conservation program, but no considerable outcomes have been achieved so far. This shows the infirmities of the regulatory authority for energy proficiency of the country. The financial management, energy purchase and sales and in the appointment of senior management over the operating companies (GENCOs and DISCOs) has been deleteriously influenced by the centralization of PEPCO.[218] The incompetence of government is also revealed in the approaches of its decision and policy making by reason of which energy supply is restricted. On the contrary, it is essential that private investors are given with some relaxation in the regulatory restrictions for the purpose to attract private investment in a country. Apart from it, NEPRA takes approximately 6 to 10 months to determine tariffs. In addition to it, further delays in the implementation of government decisions, and discouragement of investors caused by the sophisticated bureaucratic procedure and lack of administrative competence. For instance, despite separate determinations made by NEPRA earlier, the government delayed the announcement of separate tariffs for all corporate distribution companies[219] The entire organizational setup of energy sector is very multifaceted and has adverse implications on energy supply this condition of NEPRA is no exception.

[218]"Friends of Democratic Pakistan", Integrated Energy Sector Report and Plan, FODP, (2010)
[219]Afia Malik, "Power Crisis in Pakistan: A Crisis in Governance?", PIDE Monographic Series, *Pakistan Institute of Development Economics*, (2012)

Primarily, in Pakistan, NEPRA was developed as regulatory authority. However, it controls and monitors energy market (energy market is outlined as the trade of energy commodities). Whereas, in Pakistan, a single energy market regulator or a single integrated energy regulatory authority is not found which considered as the one who safeguards the interests of all stakeholders in energy market competently. Particularly, in their corresponding roles NEPRA and OGRA also lack autonomy. They generally make confusions among investors and pricing planning between oil and gas departments. There are also signs of poor efficiency showed by the public-sector companies, which are producing less amount of energy per unit of fuel as compared to private energy plants. While where some of Pakistan's plants require up to 14,000 to 15,000 btu per kWh, the efficient plants use about 8,500 btu to generate one kilowatt-hour (kWh) of energy Although, the government seemed fail in enforcing commercial discipline and accountability on utilities as it is understood by government and NEPRA that these inefficiencies and mismanagement issues need to settle. NEPRA has set targets for all distribution companies, whereas, no procedures were taken when these targets were not met. Eventually, the government ends up paying for these extra damages, with the purpose of clearance of the country's circular debt.

Almost all explanations of energy supply crisis are complicatedly amalgamated. From the above detailed discussion on factors behind insufficient supply this research extracts that most of the problems are a result of bad governance, ranging from circular debt, tariff determination, decision making, and mismanagement inefficiency. Good governance is a course of making and implementation of decision with efficiency and accountability. However, in the precedence of these key issues, Pakistan suffers from institutional and structural disconnections and mismanagement. Therefore, it is understood that, either by complimentarily approving public investment inappropriately or by imperilling exceptionally important projects for their vested benefits, vast damages have been caused by policy makers.

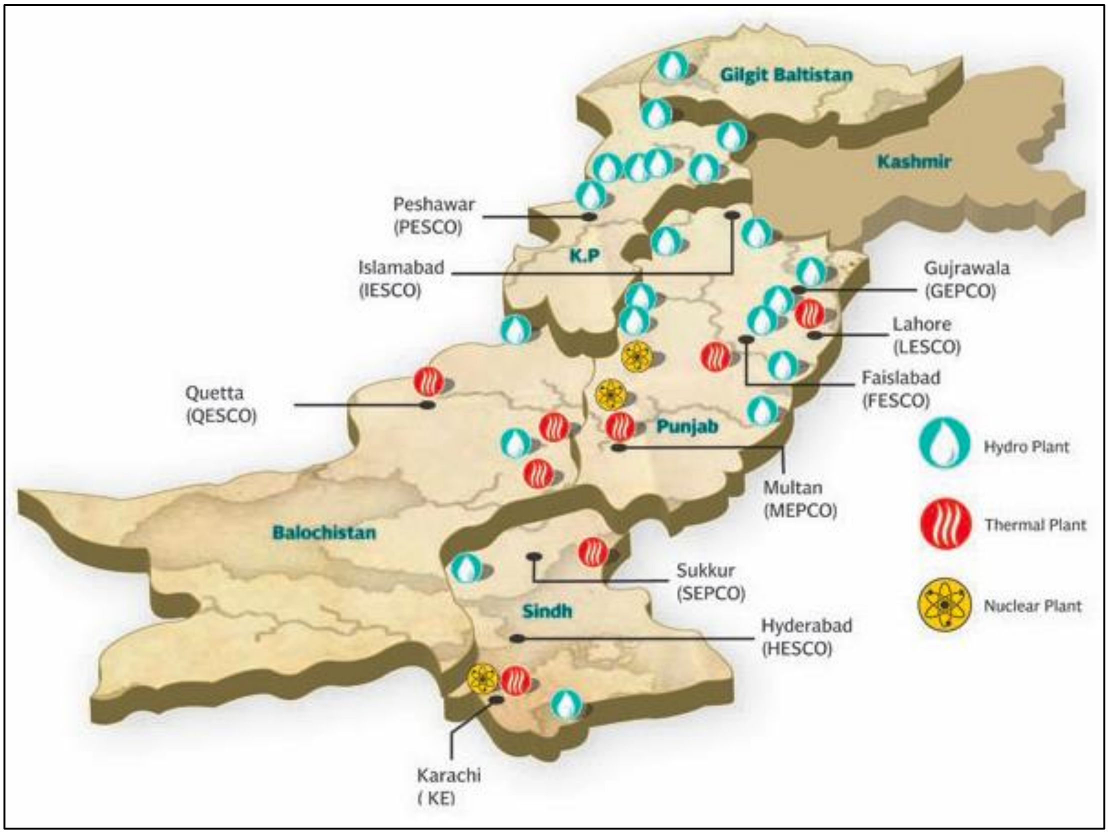
**Malady of Multiple Institutions in Pakistan's Energy Governance:** In Pakistan, till 1990's, Water and Power Development Authority (WAPDA) and Karachi Electric Supply Company (KESCO) were managing the energy sector. Both departments were responsible for the production, transfer and distribution of electricity. Till 1990's, the performance of both sectors was satisfactory before abrupt upturn in energy demand and other serious matters including high level of losses because of corruption, bad governance and inefficiency. In this matter, restructuring of energy sector was initiated in the form of "Strategic Plan for Restructuring the Pakistan Power Sector [PPRSP] in 1992," which was endorsed by the Government of Pakistan (GOP)/ Council of Common Interest (CCI) and followed by Energy Policies of 1994 to 2002.[220]

In 1997, "The Regulations of Generation, Transmission and Distribution of Electric Power Act" was presented. NEPRA was under this framework created as entirely autonomous regulatory authority. WAPDA's power wing was exclusively restructured and transfigured into further four entities. These include GENCOs, DISCO's, NTDC and KESC (Karachi Electric Supply Corporation). This distribution of responsibilities was taken within the frame of corporate law and was taken under the administration of PEPCO (Pakistan Electric Power Company) (See Figure 3.3). Later, KESC was privatized and renamed as K-electric. The memorandum and articles of association of PEPCO was signed in 1998.

As an outcome of this restructuring, two interconnected energy systems are placed in a country. First one is the Pakistan Electric Power Company (PEPCO) which is a public entity. It comprises number of governmental thermal energy generation companies including a transmission company (NTDC), the distribution companies (DISCOs) which is responsible for providing energy to entire country excluding Karachi. The K-Electric Limited, which is functioning in Karachi, the sole private vertically integrated energy utility in Pakistan and is responsible for generating or buying energy from IPPs falling in the area, and its further distribution. Second is the Central Power Purchasing Agency (CPPA) which functions as the only energy consumer for the PEPCO system while National Electric Power Regulatory Authority (NEPRA) regulates price, quality and entry into industry.

[220]Lodhi, *Costing and Tariff Sector in Power Sector in Pakistan.*

**Figure 3.3: Power Companies in Pakistan**

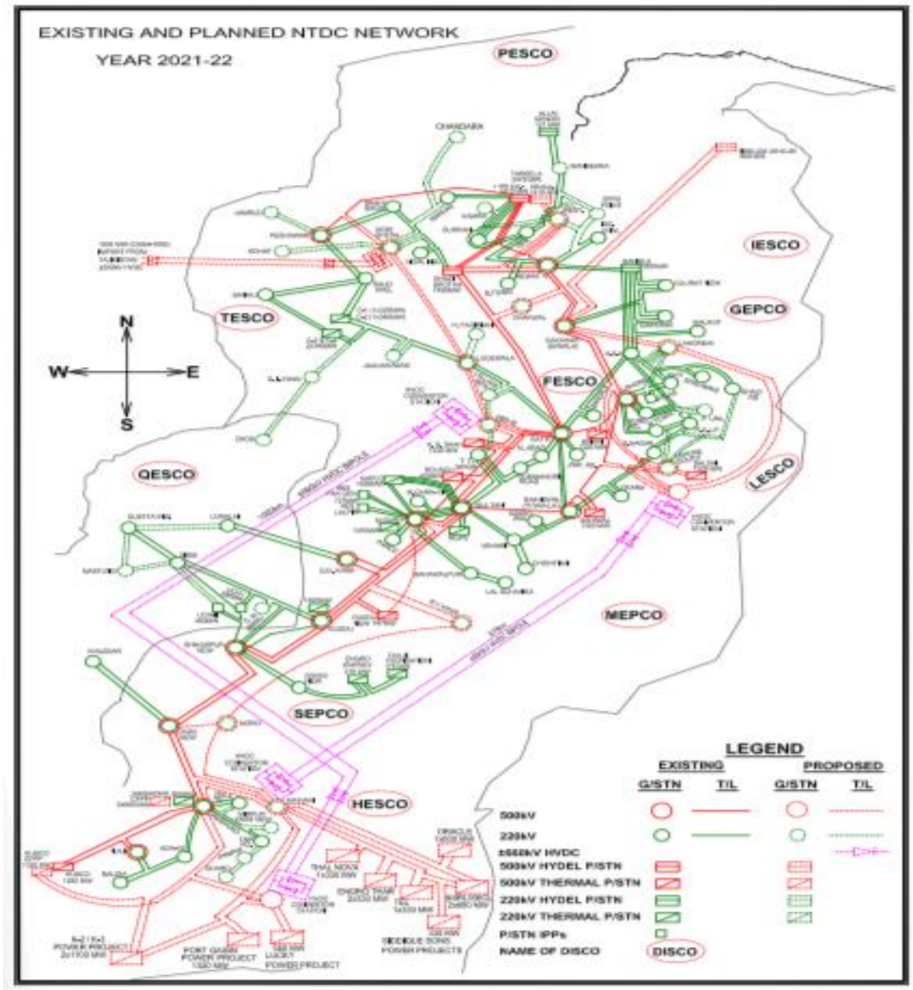



**Source: Spearhead Research**[221]

Public generating units and private-owned Independent Power Plants generate energy which is collected into national grid operated by NTDC. NTDC further transmits the same generated energy to the ten DISCOs networks for onwards distribution to consumers. The system is well explained in Figure 3.4.

[221] Zafar Bhutta, "Burden of Power: Why we are in the Dark-Spearhead Research-Pakistan", *The Express Tribune*, (5 May 2015)

**Figure 3.4: Existing and Planned NTDC Network, Year 2017-2021/22**




**Source:** NEPRA, *State of Industry Report 2017*

While assimilating the DESCOs north-based hydro energy plants and south-based fossil fuel-based energy generation facilities, NTDC's transmission network comprised of various other corridors (See Figure 3.3).[222] Of the 15011 km long transmission lines, 5197 km operate at 500 kV level and 9814 km at 220 kV. In addition, a 37 km long 132 kV D/C transmission line was also energized in 2016 by Fatima Transmission Company Limited, a 95 km long 132 kV D/C transmission line of Sindh Transmission and Dispatch Company Limited (STDC) was completed and construction on 878 km long HVDC bi-pole transmission line operating at 660 kV was also initiated. The NTDC system entailed fourteen 500 kV grid stations with a transformation capacity of 18,624 MVA and thirty-eight 220 kV grid stations

[222]"State of Industry Report 2017", *NEPRA*, (2018), p. 63

with a transformation capacity of 25,660 MVA, by the end of FY 2017. A total of thirty-three 500/220 kV transformers, thirty-five 220/132 kV transformers and one hundred eight 220/132 kV transformers were installed and equipped at these grid stations. During FY 2015-2016, NTDC invested PKR 28.22 billion in transmission infrastructure and during FY 2016-17, it invested PKR 49.81 billion.

**Malady of Pakistan's Energy Mix:** As quantified in another place, hydel energy remained the backbone of Pakistan's energy mix till 1990. However, from that point, the share of thermal-based energy production, comprising on natural gas, residual fuel oil, high-speed diesel and coal, grew disproportionately. Total installed production capacity was 28399MW in the end of FY 2017. Of the total installed capacity, thermal energy generation capacity stood at 18676MW, whereas, hydel remained immobile for the third consecutive year at 7116MW (including 214MW generated by private independent energy plants), nuclear at 1142MW, and renewable energy at 1465MW. From the thermal energy generation, 6785MW was generated from oil, 810MW from coal, and 8868MW from gas/RLNG. Several other energy plans are supposed to join the national grid by 2019 as about 9300 MW of CPEC projects comprising coal, hydro energy and renewable energy, while a supplementary generation capacity of 2880MW is under construction.[223]

Along with increase generation capacity, the supplies of natural gas, oil, hydro energy, coal and nuclear increased from 58.06 million tonnes of oil equivalent (Mtoe) in FY 2006 to 70.27 Mtoe in FY 2015. Natural gas and oil accounted for 43% and 36% of total primary energy supply (TPES) in the year 2015. Whereas, in June 2014, the balance of recoverable reserves of natural gas dropped from 31 trillion standard cubic feet (Tscf) in 2009 to 23.64 Tscf. In February 2016, as Pakistan joined a 15-year agreement with Qatar, the share of natural gas continued towards the upwards tendency, as a country's import is up to 3.25 million tonnes of LNG annually, at a relatively higher price at 13.37% of the previous three-month average Brent crude oil price.[224]

[223]Pakistan Atomic Energy Commission, "Nuclear Power: A Viable Option for Electricity Generation," (2017), Available At: www.paec.gov.pk/NuclearPower/ Access On 03-10-2019

[224]Krista Mahr, "Pakistan signs landmark 15-year LNG supply deal with Qatar", *Reuters*, (10 February 2016)

In Pakistan, as far as the insufficient energy supply is apprehensive, the main cause of energy crisis is the unbalanced and instable energy mix. Energy generation is heavily based on fuel-oil imports. The above-mentioned energy generation mix of Pakistan demonstrates that the portion of hydro energy in the energy mix was central in the early years. Till 1980's, out of the total energy generation 50% was based on hydroelectricity but later on it started declining it reduced to 29.4% in 2010. The development of hydro energy could only be provided through projects like Tarbela and Mangla Dams which were constructed in the 1960's and 70's. Additional continued development was totally stopped and till Ghazi Barotha Project, there was no other construction of major dam for the next three decades. The lopsided energy mix of a country demonstrates that for the purpose of fulfilling the increasing demand of energy in 80's and 90's, the government, after ignoring hydro energy, started relying on fossil fuel generation. The variations in oil prices in international oil market have transformed the energy mix to unsustainable and uneconomical one, as the oil used in fossil fuel-based energy generation is generally imported.

**Malady of Centralized Energy System:** there is no specific research which has been done on centralised system of energy management as a factor of insufficient and inadequate energy supply. The centralised system of energy is very briefly discussed in the existing literature which also focusing from other angles on issues related to the system. However, it has not been portrayed as a contributory factor towards energy crisis, especially of supply side. However, most of these issues originated from centralised system. An extensive transmission and distribution network is required to supply energy to the consumers, as the energy generating units are positioned away from populated areas. On the contrary, essentially due to line losses during transmission and distribution, the costs for transmission and distribution which is almost 30% accounted for the cost of average delivered energy in centralised generation, whereas, it is unaccounted for energy and conversion losses (e.g., changing the voltage from high to medium and low). More specifically, this problem becomes critical in the case of electrification of low populated rural areas. During FY 2015-16 as it is one of the contributors of circular debt, transmission and distribution losses, remained at

18.7%.[225] During the period of FY 2016-17 even the improved 17.9% losses against the authorised target of 15.27% at national level (excluding K-Electric) resulted in gap of over PKR 31 billion annually. Hence, even though installed capacity matches the demand, these increased tariffs and resultant non-payments of bills and theft contribute further to circular debt and suboptimal generation.

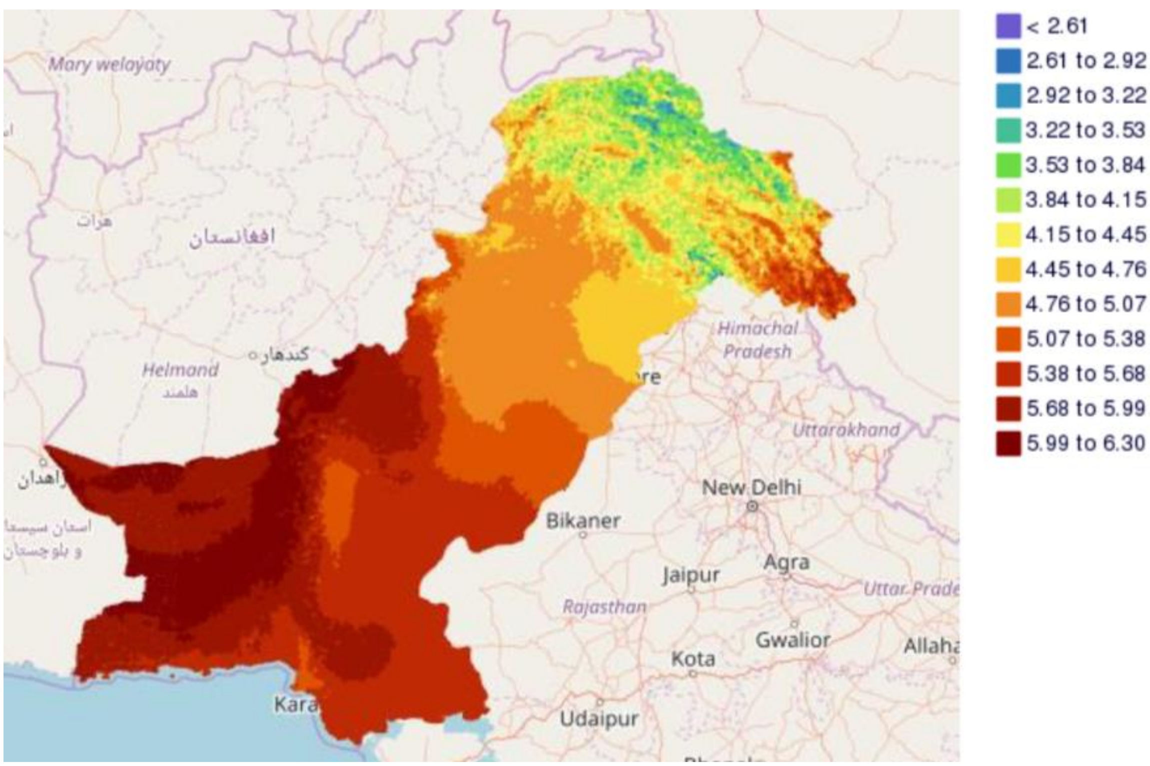
On the contrary, with manifold reasons, in centralised generation the increased energy demand brought the existing transmission and distribution network under unembellished stress. Constituted for a certain energy load, to supply the increased quantity of energy and cater for future demands, the existing transmission and distribution networks would need massive up gradation. In Pakistan the existing energy system is ageing, heavy on maintenance and functioning at unsatisfactory level. Out of thirty-three 500/220 kV transformers, 13 (i.e., 39%) are loaded above 80% of their rated capacity while 79 transformers out of the total one hundred forty-three 220/132 kV (i.e., 55%) are overloaded. In 2015, NEPRA evaluated that NTDC would need about USD 9 billion to establish substations and transmission lines in order to energy exhaustion from the planned large hydro energy, coal and nuclear energy projects. The last two decades have witnessed a renewed interest in distributed generation owing to the developments in decentralised (commonly known as distributed) generation technologies which restraints on the construction of new transmission lines, increased customer demand for highly reliable electricity, the energy market liberalisation and concerns about climate change. Appropriately located decentralised generation units can mitigate the transmission losses which are connected to distribution, rather than transmission grid. It obviates the need for heavy investment in transmission and distribution lines over long distances. It also ensures that efficiency, as cogeneration, can raise energy efficiency from 40% to 90%, where the waste steam is reused in a neighbouring heating or cooling system.[226] As heat cannot be easily transported over long distances, the system is viable for decentralised generation only. On contrary, it can mitigate the greenhouse effect concomitant with fossil fuel-based centralised generation, as the best suited for renewable technology.

[225]NTDC, "Power Data Reference Book Nov 2010-July 2016", *Power Plan,* NTDC2, No. 1, (2016), pp. 1-3

[226]"Intergovernmental Panel on Climate Change (IPCC)", *Climate Change 2007-Miligation of Climate Change: Working Group III Contribution to the Fourth Assessment Report of the IPCC* (2007)

In Pakistan energy system is aggrieved with all these problems, necessitating a measured technological intervention. It has become a compulsion for Pakistan, with the immense potential for decentralised generation, particularly in terms of renewable technology, to change to decentralised generation acceptable to address the persistent energy supply crisis. Solar technology in part of the country, offers the best option in this regard. Some efforts have gone into decentralised generation system in post-18th constitutional amendment allowed provinces to generate electricity. After feasibility studies in 2013, KPK government commenced upon determined plan of developing 356 MMHPPs. It is qualified for distributed generation, out of which 255MMHPPs with 13.445MW generation capacity have been accomplished.[227]

**Figure 3.5: Solar Irradiance Map of Pakistan**




**Source:** Global Horizontal Solar Center, (2018)

[227]"KP Govt Completes 255 Mini Hydropower Projects, Proposes 7 Projects for Inclusion in CPEC", *The News*, (30 September 2018)

Energy governance is found less attentive to solar technology utilization though Pakistan is potential country to avail solar energy (See Figure 3.4 and 3.3).

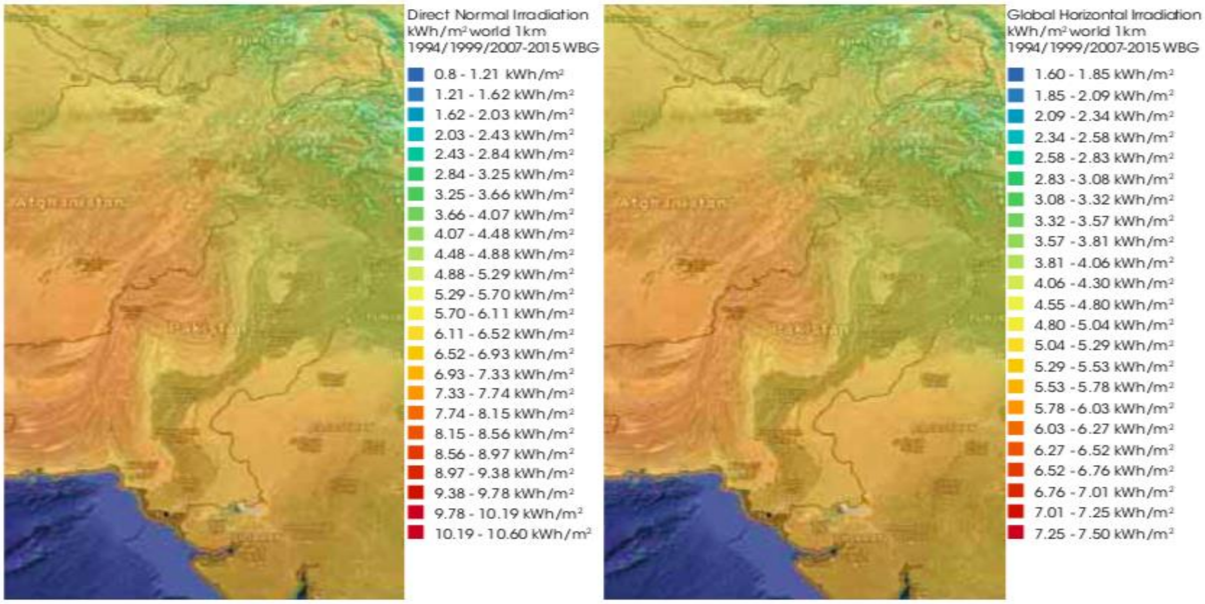
In Pakistan, there is a great potential for hydel projects in the northern part of the country, its southern and south-western parts recorded greater irradiation levels which starts from South Punjab, which is the highest annual global horizontal irradiance. For solar PV installations, there is a good resource measure which achieved in the Balochistan, as assessed peak values exceed 2700 kWh/m$^2$per year in Western Balochistan, whereas, 83% area of the land still have potential of producing2000 kWh/m$^2$per annum. Most of the values are found around the Sinai Peninsula which can be attractive for the investors from the Middle East and North Africa.[228] Figure 3.6 show the solar irradiance maps of Pakistan.

The decentralised generation with small run-of-river hydro energy projects, are executed in northern parts of Pakistan. For this reason, the massive potentials for solar-based decentralized generation stay unused. The government is investing prominently in establishing new generation units and in the transmission and distribution system but they are still comparatively less than generation which support evacuation of energy from these facilities. When the government electrify the outstanding 77% of the rural population, which is mostly distributed in small villages in interior South Punjab, Sindh and the sparsely populated Balochistan, the latter will be particularly costly. Unexpectedly, these same areas particularly South Punjab, are perfect for solar energy generation. Micro grids can be an effective and economically viable solution in the long run. It will take the load off the transmission and distribution system, not only to basic electrification of these remote and thinly populated areas, but also, with the supplementary large, supply generating projects in pipeline by decreasing the investment in its up gradation and maintenance. As a result, following central restraints need to be addressed.

[228]Anjum Ahmad and Oliver Knight, "Renewable Energy Resource Mapping in Pakistan", *World Bank-Energy Sector Management Assessment Program-ESMAP*, (2014)

**Figure 3.6: Pakistan Solar Energy Potential Map**

Local and Global Irradiation




**Source:** IRENA (n.d.) *Global Atlas for Renewable Energy*, using data from World Bank-

India is found with better energy security specifically low-cost rural electrification has already been provided through the commercial scale Mera Gao Energy (MGP) micro grid. It connects over 10,000 households spread across400 villages and which provides 5W of DC energy to each subscribing house in a village, and in Uttar Pradesh through 1 kW DC micro grids in 11 districts covering around 4,000 houses.[229] Similarly in African continent, it includes up to 600W micro grids and small container based solar solutions on 12V and 24V which are being promptly utilised in Africa[230] However, these solar solutions generally provide lighting and mobile phone charging typically up to 10W for 8-hr daily operation. The requirement in Pakistan is more sophisticated which needs 24/7 operation, suggesting "a mismatch between low-cost low-energy technology and the demand for electrification in the Pakistani context".[231]

[229]Ashok Kumar Srivastava, "Solar Minigrids in Rural Areas of Uttar Pardesh", *Akshay Urja*, Vol. 4, No. 6, (2013), pp. 16-17

[230]Paras Loomba, Sonal Asgotraa and Robin Podmore, "DC Solar Microgrids-A Successful Technology for Rural Sustainable Development", *IEEE PES Power Africa*, (2016), pp. 204-208

[231]Husnain Fateh Ahmad, Hassan Abbas Khan and Nauman Ahmed Zaffar, "Decentralised Electric Power Delivery for Rural Electrification in Pakistan", *Energy Policy*, Vol. 120, (2018), pp. 312-323

**Malady of Legal Constraints:** NEPRA laws in Pakistan are currently only facilitating the private energy generation for the personal use, though private parties are not allowed to sell the generated energy. These feasibilities in NEPRA laws will encourage the self-financed energy generation for self-consumption. Similarly, at the provincial level, the provinces can generate their energy within their due capacities though they are not allowed to use this generation respective to the provincial needs. Hence, there is a need to review this legal framework to facilitate private enterprises and provinces to operate independent of the national grid.

**Malady of Technological Barriers:** As stated earlier, the current available cost-effective technologies offer low-voltage DC current for 8 hours only; the cost would rise considerably for higher voltage and 24 hours operation, which would entail larger generation and storage facilities. A study to enumerate optimal size related to our villages' pattern essentials to be conducted while taking into account our sub-regional particularities.

**Malady of Circular Debt:** As there is a requirement to pay expenses related to generation, transmission, distribution and other related expenditures, the energy sector is in dire need of revenue. The financial ability of energy entities is under severe challenge because of the problem related to circular debt. The payments from different stakeholders including energy consumers, private producers, the national transmission agency, distribution companies, and the government departments are generally unpaid and remained due. Together with inadequate tariff, theft of electricity, corruption, losses, disagreements on tariff within FATA, AJK and KESC, role of federal and provincial institutions in delaying the payments, this disparity in generation cost and revenue gathered by PEPCO accumulates over time into huge sums owed to the generating companies. Due to losses suffered there is an increase in tariff as PEPCO is already incapable to meet its expenditures. In turn, further decrease in revenue take place as higher cost of energy promotes illegal use of electricity. Furthermore, these problems aggravate the issue due to insufficient tariff or dispute on tariff within various energy departments.

In 2006, this issue of circular debt has intimidatingly been surfaced, during Pervez Musharraf's regime. It happens when the oil prices rose internationally, whereas, the government took decision not to pass the burden on to the consumers in the form of high energy prices. The circular debt reached PKR 111 billion resultantly, however, during Nawaz Sharif's government it has reached a record of PKR 480 billion.[232] By the time the current government assumed office in August 2018 it was touching a whopping PKR 1.148 trillion.[233] Consequently, owing to non-payment, even the energy related departments and energy supply companies are unable to provide energy if they have installed generation capacity on the basis of this circular debt issue. Experts believe that the problem of circular debt can be handled properly and effectively by reducing the energy supply limitations.

**Malady of Price Determination Mechanism:** Formerly, through an act of parliament in 1998, NEPRA was set up to regulate all the elements of energy sector. However, for the ratification of NEPRA tariff rates, an official notification was required from the government by the official channel. It again causes further delays and discretion. The government did not adjust consumer tariff, between the years 2003 and 2008. Tariffs were revised on regular basis subsequently afterward; however, those adjustments were dependent on the increased cost of supply while shortfall of the year 2003–08 remained unresolved. The government raised tariffs from less than PKR 5.50 per kWh in 2009 to PKR 9 per kWh by 2012.[234] As there is great variance between tariffs decided by government and NEPRA, so in this regard the significant shortfall is that there was no unified tariff determination in Pakistan which necessities to oblige the international changes. Increased tariffs lead to energy theft which in turn imposing further hike in tariffs to bridge the gap between revenue and losses which furthermore acquires more circular debt with bankrolled tariffs. These fashions a spiteful rotation entrained mainly due to mismanagement, inefficiency and unrealistic decisions by government.

[232]Syed Fazl-e-Haider, "Circular Debt Leaves Pakistan in the Dark", *Business,* (27 December 2014)
[233]Zafar Bhutta, "Circular Debt of Rs 1.1 tr Passed on to New Govt", *The Express Tribune*, (18 August 2018)
[234]Rashid Aziz and Munawar Baseer Ahmad, *Pakistan Power Crisis: The Way Forward* (Washington: United States Institute of Peace, 2015)

**Malady of Fragile Security Situation:** In terms of improving energy development the prevailing security condition in Pakistan is not encouraging. Due to weak security infrastructure, the main areas of Pakistan with enormous energy reserves, for instance Balochistan and KPK, have failed to attract foreign investors at their fullest. From different grievances terrorism and restricted threats are originating which considered as main security issues related to energy security. Any possibility of investment in energy sector is rolled back, with such security uncertainties. The availability is also suffered gravely due to persistent bombing of gas supply lines and energy transmission systems in addition to the shrinkage in energy. The progress of exploration and production of petroleum and gas in hydrocarbon rich areas has badly hampered due to the undesirable security situation of country.

**Malady of Poor Transmission and Distribution (T&D) System:** In 2018, installed capacity is 29,573MW while in FY 2012-13 it was 22,812MW. Despite constrains, energy production increased from 96,496GW/h in 2012-13 to 117,326GW/h in 2016-17, with 30% growth rate. During first eight months of FY2017-18, through nuclear power plants of Karachi and Chashma, 1430MW were added.[235] During 2017-18, the transmission system of NTDC has been strengthened. In national grid, some certain energy transmission lines were added which read: 4340 MVA, 2700 MVA on 220 KV and 500 KV. The system of current transmission lines was extended by adding 372 KM on 220 KV and 1157 KM on 500 KV.[236]

Despite the above-mentioned transmission and distribution capacity, the losses are frequent and they are causing dielectric, open circuit, leakage current and power losses. In 2018, Pakistan was confronting 18.3% transmission and distribution losses which were adding to the already high tariff prices.[237] As compared to transmission, distribution losses are higher mounting to 87%.[238] Table 3.7 shows T&D losses.

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[235]"Pakistan Economic Survey 2017-18", *Finance Division*, (Government of Pakistan), pp.210-17

[236]"Pakistan 2025", Annual Plan 2018-19, Government of Pakistan, Planning Commission, *Ministry of Planning, Development and Reform*, (2018), p. 131

[237]Zafar Bhutta, "Circular Debt in Energy Chain Swells to Rs 1.18 Trillion", op.cit

[238]Shakeel Khan and Farhan Ashraf, "Analysis of Pakistan's Electric Power Sector", *Blekinge Institute of Technolog*y (March 2015), pp.37-38

**Table 3.7 Transmission and Distribution Losses**

| | |
|---|---|
| Units Available for Transmission | 100,871 GWh |
| Transmission Losses (NTDC) | 2,623 GWh (2.60%) |
| Distribution Losses (DISCOs) | 16,762 GWh (17.02%) |
| Total T&D Losses | 19,385 GWh (19.6%) |

**Source:** Power System Statistics 2015-16 (NTDC)

Poor governance and mismanagement are two major issues of energy sector. In power economy, this framework cannot sustain itself. In 2019, Pakistan is facing 18.3% transmission and distribution losses.[239] In these losses, ratio of distribution losses in higher in comparison with transmission losses. The phenomena of T&D losses is not merely attributed to Pakistan. India is also facing 31-32% T&D losses. However, in comparison with Pakistan, Indian energy sector authorities are seriously handling or at least trying to handle the issue of T&D losses. They are taking concrete steps to reduce T&D losses. For example, in capital they have already reduced these losses to 21-22%.

It appears that in Pakistan most of the problems contributing to energy crisis are shaped by the energy governance of Pakistan. Energy governance determined to handle unbalanced energy mix, depletion of fossil fuels, circular debt, decision making delays, gap between installed capacity and actual generation, corruption, mismanagement can become a source of energy security of Pakistan. The demand of energy is increased because of the rising temperature and protracted summers. High population growth with increased socio-economic development and the energy-based luxury prosperity have further supported the energy crisis. Lack of affordable and clean energy has become a threatening issue in economic strategy of Pakistan.  It is observed that many small industries have shut down, which are largely the result of inefficiency rooted in centralized energy system due to the dearness of energy.

Various energy policies of Pakistan are well examined in chapter 4. The chapter will explain the prevalent energy policies and practices which are adopted by energy governance of Pakistan. The chapter will discuss the idea of institutions and energy governance in Pakistan by explaining; the alignment of expectations and actions, the development of coordination, and the setting for mutual benefit. The topics of discussion would be energy agenda of political parties in Pakistan and their energy policies while ruling the country.

[239] "Distribution Firms Suffer 18.3pc Line Losses This Year", *Dawn*, (28 January 2019)

# Chapter 4

# Energy Governance of Pakistan in Flash of Political Parties and Energy Policies

## I. Informal Institutions and Energy Governance of Pakistan

A. Pakistan People's Party and Energy Security /Energy Crisis of Pakistan
B. Pakistan Muslim League (N) Party and Energy Security /Energy Crisis of Pakistan
C. Pakistan Tahreek e Insaf Party and Energy Security /Energy Crisis of Pakistan

## II. Formal Institutions and Energy Governance of Pakistan

A. Pakistan People's Party Regime and Energy Security /Energy Crisis of Pakistan
B. Military Regime and Energy Security /Energy Crisis of Pakistan
C. Pakistan Muslim League (N) Regime and Energy Security /Energy Crisis of Pakistan

## III. Commissions and Omissions of Energy Governance of Pakistan

A. Commissions: The committed energy decisions and actions; caused the energy crisis in Pakistan e-g, IPPs Project
B. Omissions: The omitted energy decisions and actions; caused the energy crisis in Pakistan e-g, Kalabagh dam

## IV. Pakistan China Economic Corridor

# Chapter 4

## Energy Governance of Pakistan in Flash of Political Parties and Energy Policies

In this study energy governance is about the structure and performance of the institutions referred energy crisis of Pakistan. The study considers the role and the behavior of the political parties as informal institutional political perspective of energy governance; while the energy policies are considered the formal institutional political perspective of the same. In the state of Pakistan, the political parties and policies have provided an order and structure by aligning the decisions and actions in specific fashion. The relationship has forged a structure to serve the enormous interests of the governing features causing energy crisis in Pakistan. The trend is inclined to decrease the mutual benefit of the state and the society as the available energy is neither affordable nor clean. The set of idea is deliberated in chapter 4 through following questions:

a. What kind of correlation exists between political parties of Pakistan & energy policies and energy crisis of Pakistan?
b. What is the role of political parties and their manifestoes in energy security and energy crisis of Pakistan?
c. What is the role of energy policies in the evolved energy crisis of Pakistan?

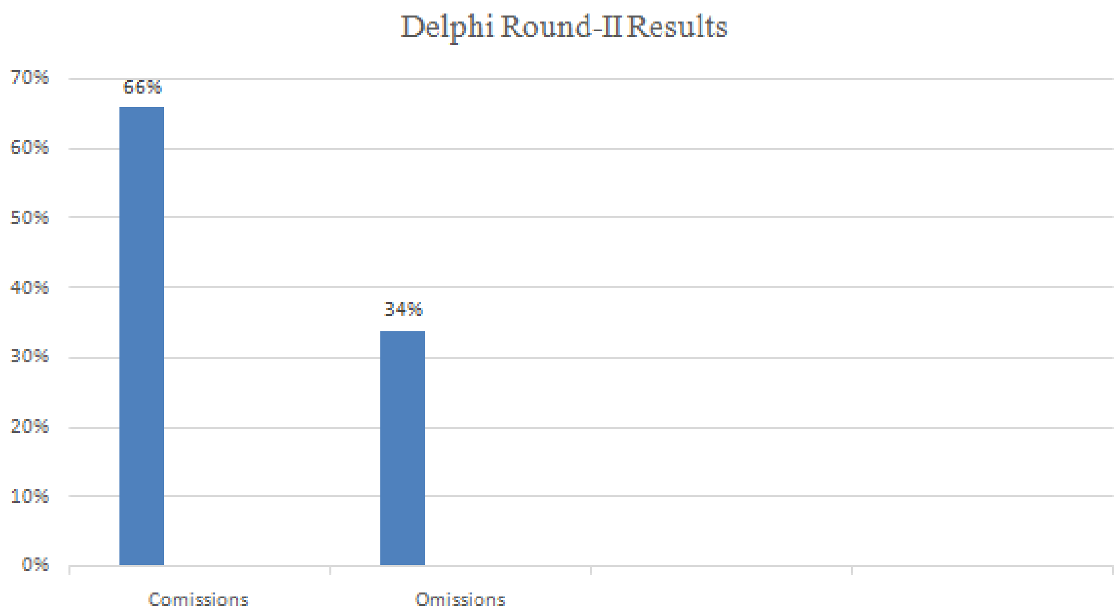
**The study identifies energy institutions composed of all decisions and actions of legislature, executive and judiciary bearing the capacity to affect the energy resources of the state.**

The energy institutions in Pakistan are set to achieve the objective of reducing uncertainty in the development of energy. Institutions are evolved through different constitutions, legal procedures, contracts between individuals, norms of the statue and common laws. They have defined structure of economy to increase feasibility and profitability during energy development. The energy governance of Pakistan has emerged from the combination of politico-economic behavior of politicians on treasury benches or in opposition

of the government. The source of divergent energy decisions and actions is the political and business affiliations of the individuals working in institutions. The energy institutions at national level spell their rules into provincial and community levels of governance. Institutions offer a reliable and structural way of communication with incremental changes.

Better knowledge, factual data and variability of valuable attributes provides the way for maximum dependence on institutions for a structured and cost-effective energy development. Institutional change through the alternation in the formal rules of game is the best way of increasing return features of an institutional framework. Political parties impose constraints on interaction to structural changes in the energy institutions.

Figure 4.1: Round II: **How do you prioritize the reasons of energy 'Crisis' in Pakistan referred Energy Governance of Pakistan?**




*Commissions: The committed energy decisions and actions; caused the energy crisis in Pakistan e-g, IPPs Project
*Omissions: The omitted energy decisions and actions; caused the energy crisis in Pakistan e-g, Kalabagh dam

The specialized interdependence occurs between the institutions because of specialized interest e-g, energy development. Institutional and technological interactions define

transaction costs[240] that are summed up to proclaim production cost. Chapter 5 assesses the CPEC projects following the energy security index. This study identifies the two dynamics of energy governance of Pakistan one is formal institutions and the other political parties and their manifestos as informal institutions. The institutional and technological interactions are defined in perspective of China Pakistan Economic Corridor (CPEC) signed in 2015. The Delphi round 2 results are presented on the basis of responded knowledge and expertise of 15 experts for this study (See Figure 4.1). The study found that the energy crisis has been evolved in Pakistan because of 66% commissions. Commissions: The committed energy decisions and actions; caused the energy crisis in Pakistan e-g, IPPs Project. 34% respondents reported that the energy crisis accumulated in Pakistan because of omissions. Omissions: The omitted energy decisions and actions; caused the energy crisis in Pakistan e-g, Kalabagh dam.

## I. Informal Institutions and Energy Governance of Pakistan

This section highlights the space of energy security/crisis in the structure of informal institutions of Pakistan. It establishes that the political parties in Pakistan well access and utilize energy predicament to secure their vote bank.

Pakistan is led by democracy. The two leading parties namely Pakistan People's Party and Muslim League have ruled for several years. Apart from that the country has also been through military control thrice since it came into being. Recently Pakistan Tehreek e Insaf came up as the most popular party in Pakistan in 2018. Each political party has its own sort of priorities that are reflected in its manifesto. This is from where they win the hearts of their voters. It is important that the manifesto presented until now are revised carefully. It would provide how significant the energy sector improvements are for each party is. This helps in figuring out what are they likely to put for eliminating the curse of energy crisis from the country. Until the year of 2002, energy sector was not given its due attention. The issue of energy crisis was also not brought up according to the magnitude of the prevailing energy crisis. The economic prosperity of the company was associated with other developmental

[240]Transaction Cost: In this Study Transaction Cost and its Effectiveness is Measured as Per the Energy Security Index

agendas, which were given more preference. A brief summary of main political parties' manifestos is as follow:

## A. Pakistan People's Party and Energy Security/Energy Crisis of Pakistan

On 30th September 2002, the manifesto of PPP was published. The title of the manifesto was for a just, equitable and egalitarian Pakistan. The manifesto covered the socio-economic aspects that needed attention. That included the parties' agenda on alleviating poverty, reducing debt, fostering peace and curbing any kind of terrorist activities in the country. The reform required in the education system was thoroughly discussed.

It suggested that the education system can be improved by facilitating the schools. It could be done by providing internet facility, textbook and establish libraries etc. In addition, the improvement required in the health sector was also discussed. It was based on the slogan that "healthy body of healthy society". It planned to establish hospitals, health centers and old homes. The system of justice should also be accelerated, it suggested. Under this manifesto the idea of family courts and small cause's courts was generated. The foundation of the manifesto was laid under the heading of faith and freedom. This believed on the idea of equal opportunity, human rights and freedom of speech.

Pakistan People's Party (PPP): In 1970s's Pakistan People's party won the elections. This party is one of the oldest leading parties of the country. Followed by success in 1990s as well, the party maintained its popularity among the masses. It was unable to complete its tenure even after winning the elections twice in that decade. In 2008 once again it was given the opportunity to form a government that was to be made with alliance with other parties of the company. The party relies on the belief that every individual should at least have the basic necessities of life. In addition to this, social justice and learning has also been given significant importance in the manifestos provided by the party. The focal point of the manifesto presented in 1993 was that the economic growth should be driven by sustainable development.

In 2008, the manifesto presented was even more detailed as compared to the previous manifesto. Improvements to be made in the energy sector remained the main focus of the party. It mainly focused on the generation of energy through hydel power as the main source. The new projects planned were initiated with the idea that they would help in the overall prosperity of the economic conditions.

The party planned to improve the macroeconomic issues. It implied that the economy shall have a consistent growth rate, without any uncertain hikes in the prices. The peace of the country shall be maintained by monitoring any kind of terrorist activity. The basic amenities of life included shall be provided that includes healthcare, safe drinking water etc. In short, the major issues related to the socio- economic and environmental development were enclosed in the document.

The main stay of the manifesto regarding energy sector was based on providing energy security. Energy consumption is an indicator of the living statndard of the country. the manifesto proposed three projects Ghazi Barotha hydroelectric power project with the capacity of 1450 MW, 300 MW nuclear power station at Chashma, with the capacity of over 5000 MW of private power generated. It encouraged that energy shall be generated through indigenous hydro and hydrocarbon resources. It also aimed to complete the Thar coal plant and KetiBundar project. Energy shall be produced by utilizing the local resources and the private sector was also encouraged.[241]

The incentives provided to the private sector in the policy introduced in 1994 encouraged private investments. The plans could not be completed due to which the efforts for reducing energy shortages could not be accomplished. It suggested that the use of renewable resources to produce energy will reduce the reliance on imported fuel. The use of coal was promoted instead of using furnace oil. The importance of using indigenous resources was stressed upon so because the country was already heavily indebted. The independent power producers (IPPs) were to invest 36 billion US dollars. Pakistan-China Energy Working

[241] Pakistan People's Party (PPP), "Towards Peace and Prosperity in Pakistan", Manifesto 2008, Available At: http://www.pppp.org.pk/manifestos/manifesto2008.pdf Access on 04-04-2019

Group (PCEWG) was also created. Moreover, the following steps were also taken that included:

- Endorse foreign investment by creating policies, procedures, and tax and pricing regimes with respect to petroleum exploration and production.
- Information regarding wind and solar energy will be accumulated across the country and green energy in all provinces in harmonisation with provincial governments will be prioritised.
- Inducements to the private sector for building run-of-the-river hydropower plants will be delivered on 70 recognized hydropower sites, and construction on storage dams, exclusively minor dams, for which there is also national consensus, will arise.
- Energy conservation bill will be presented which will concentrate on energy efficacy.
- Recruitment in NEPRA and OGRA will be done through a transparent process. Regulatory decision making will be based on transparency which will require involvement of information to lift public confidence.
- Power tariffs will be introduced by growing the use of hydro energy and coal in the fuel mix, phasing out furnace oil and diesel, and checking revenue damages in distribution companies. The circular debt will be eradicated with attentive governance.
- Supply of gas will be amplified by encouraging exploration in innovative areas, safeguarding that local communities share in the benefits, tapping tight gas and low-BTU gas resources.
- Transmission losses will be lowered to 15 per cent.[242]

The government was unable to materialize the plans it formulated in its manifesto. The country continued to generate the energy from expensive furnace oil. The reliance on IPPs remained and the Hydel projects were also not setup. The manifesto already did not incorporate the use of renewable energy in the fuel mix. Comparatively the manifest

[242]Ibid. p. 10

introduced in 2013, prioritized the use of solar and wind energy as means to produce energy. Pakistan People's Party (PPP): Ever since the party was formed, it carried the slogan of 'Roti, Kapra, and Makaan', i.e., guarantee of access to food security, healthcare services, and secure housing. The manifesto implied upon the promises made by the most prominent leader of the party namely Benazir Bhutto. She had an insight for a safe Pakistan that was based on the idea to 'save and develop Pakistan'. This aimed to have a country that shall be peaceful, prosperous and progressive every individual living in the premises of the country. This meant that even the minorities shall be treated equally. The manifesto outlined the reforms it planned to bring in the industrial sector, health sector and the education sector. It believed that the democracy should be free from any kind of directions from other institutions. The incentives to be provided to each sector were also discussed in detail. It gave its strategic direction upon jellying in the ignored provinces of the country in the mainstream such as FATA.

A very popular program initiated by the party that is Benazir income support program will carry on with its services for the public. Moreover, a "Huge Reduction Program" was initiated by the party. Realizing that the expensive unit of electricity discourages the investor and it becomes unaffordable for the local population as well. In order to promote the industrial sector, it is important that government reduces the price hikes. In addition to this Benazir Kisan Card was also introduced. This aimed at protecting the infant farmers by providing them assistance with subsidies and insurance. It realized that agriculture is a very integral part of Pakistani society and it is important that the hard work of farmers be assisted a appreciated. It also believed in women empowerment and gender equality.

In order to protect the country from the consequences of floods, it planned to build Diamer-Bhasha Dam. It was claimed that once the dam is built it can produce 4500 MW of energy. The manifesto highlighted its plans to mobilize the youth, improve heath and the education sector. The energy shortages could be covered by the initiatives taken on time by the party as it aimed at minimizing the load shedding to the least possible level.[243]

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[243]Pakistan People's Party (PPP), "BB ka Waada Nibhanan Hai Pakistan Bachana ha – Manifesto 2018", Available At: https://www.thenews.com.pk/assets/front/pdf/PPP_Manifesto_2018.pdf Access On 25-04-2019

## B. Pakistan Muslim League (N) and Energy Security/Energy Crisis of Pakistan

The manifesto of PMLQ likewise the previous manifesto reflected upon improvements in socio economic and political sector. Health and educational sector shall also be updated. The manifest laid emphasizes on reducing the expenditure rights to the foreign residents that would also give them voting rights. Strict implementation of the law will affirm fairness and security for the public. The government is responsible to give equal opportunity to everyone. The reforms to be made were stated in the manifesto. It condemned any kid of delays in the way of justice. For that matter the structure was made simple so that it in reach of a lay man. The dealing with prisoners shall also be based on humanitarian rights. The standard of education shall also be improved at all levels essentially at district and local level. Teachers shall be given their due status. The syllabus needs to be updated. It shall ensure education among the female from rural areas.

The manifesto also included the importance of good governance. It impeded that every institution shall maintain its integrity. It gave reforms for labour class, women, and employment. It also reflected upon environment, agriculture and rural development. Improvement recommended for each sector was touched.[244] PMLN remained among the leading parties of the country 2008. 19.6% voted in election were won by the party, its manifesto discussed the issues of energy gap in the country under the heading of Industrial Development. It highly recommended the use of indigenous resource and decreasing reliance on imported fuel. It highlighted the idea of energy efficiency and energy conservation.[245]

The party succeeded in securing power in the years of 1991 and 1997. In 2013, the party came into power once again. The plans to resolve energy crisis in the country were enclosed under the heading of energy security. The provision of energy needs to be continuous, and be provided at reasonable rate. This all shall be achieved through a

[244]Altaf Ullah, "The Role of Political Parties in the 2002 National Elections of Pakistan National Election of Pakistan", *Pakistan Journal of History & Culture*, Vol. XXIX, (2008), pp. 97-121

[245]Pakistan Muslim League -N, Manifesto, "Restoration of Judiciary, Sustainable Democracy and Provincial Autonomy Provided in Constitution 1973", *Aaj News,* (14 December 2007)

decentralized system. The main targets were to avoid line losses and to introduce improvement in the basic amenities provided.

The manifesto stated that the country has gone through energy crisis during the past 60 years. The gap in energy demand and supply has created a shortage of 6,000 MW. In 2010, the loss estimated was worth PKR 500 billion. In addition to this 40% of the population remains underprivileged in accessing energy to fulfil their needs. Regardless of the fact, that the country is enriched with an ample supply of natural resources. The previous government failed to succeed in several areas that were highlighted in the manifesto. It was suggested that the development in the industrial sector can help in generating employment. It also recommended a merger between Water and Power and Petroleum and Natural Resources. Moreover, a Ministry of Energy and Natural Resources was also created. The functioning of DISCO and GENCO was discontinued as they were heavily indebted. The party intended to incorporate the following steps: Lifeline end users who engross up to 100 units per month will be directed with limited tariffs

- Energy tariffs shall be informed rendering to the usual system-wide cost.
- Power dispatch to be sternly according to plant competence and generation cost.
- Transformation of all furnace oil-fired power plants to coal-fired boilers.
- Shrink distribution and transmission losses and develop collection rates.

The use of alternative resources was encouraged to generate energy. It initiated projects that would run by using coal and hydropower. That resulted in the establishment of Thar coal field and new coal fired power plants in the province of Sindh. Solar, wind, biogas and bagasse shall also be incorporated in the country’s fuel mix. These resources were

planned to be used to supply energy through micro grid and off grid. The federal and provincial government were determined to supply energy at a reasonable rate.[246]

The use of PV technology and solar thermal were prioritized while producing energy from the indigenous resources. It believed that the country cannot achieve energy if it continues to work on the same lines. The party did not declare any clear plan for considering solar energy as a source of production. The significance of renewable energy that needs to be tapped was realized. While discussing the future planning's to improve the energy sector, the party prescribes a picture of 'Roshan Pakistan'. As the country's business activity, industrial activity and agricultural sector activities were adversely affected by the extended hours of load shedding.

The manifesto clearly stated its past achievements. Regarding the future pathway it selected the party outlined that there is a dire need that the country does not only concentrate on providing the energy needed. It suggested that it should focus on providing energy at a reasonable rate with efficient and sustainable supply. It was suggested that the on grid and off grid modes of supplying the energy may help in this provision. Moreover, smart metering will be introduced. The idea was also to facilitate the farmers with any kind of assistance that could be given by the government. The party encouraged the competitive market so that everyone gets benefit according to the efforts they put in the drive to provide the best. It also encouraged the vision it gave for greener energy that relied on the use of local resources for energy generation. The insight was based on the idea that the country gets active in trade within the geographical region by 2023.[247]

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[246]Pakistan Muslim League – N, "National Agenda for Real Change – Manifesto 2013", Available At http://pmo.gov.pk/documents/manifesto.pdf Access on 05-05-2019

[247]Pakistan Muslim League – N, "Vote ko Izzat D0 – Khidmat ko Vote Do – Manifesto 2018", Available At https://www.thenews.com.pk/assets/docs/PML-N-Manifesto-Booklet-min.pdf Access on 05-05-2019

## C. Pakistan Tahreek e Insaf and Energy Security/Energy Crisis of Pakistan

Pakistan Tahreek e Insaf: the influence of PTI was just creeping in 1997. The manifesto provides by the part included all the major issues. The party stood by asking for zero corruption. It also suggested new programme initiatives for women empowerment, education, agriculture. It also attributed ways to reduce the debt of the country. Every person has a right to say and protect their rights. The rights of labour class were also protected. It implied that the role of military is to provide defence for the nation it may intervene in times of administrative disruption that may put the security of the company at stake.[248]

Pakistan Tahreek e Insaf (PTI): The manifesto discussed the major issues faced by the country such as poverty, population growth and low literacy rate. Population was growing at the rate of 2.2% at that time. It laid emphasis on the social development in order to decrease poverty. It systematically planned to improve the health sector so that the basic health facility is provided to everyone. The budget allocated to the health sector was also to be doubled. It recommended that the centralization of health sector shall shift towards decentralization. It should be ensured that the essential medication be provided with ease at an affordable rate. The provision of safe drinking water, sanitation, and sewerage and drainage system shall also be improved. Recognizing that most of the population did not had access to a balanced diet. This has also caused increase in infant mortality rate. To cater all these issues the aforementioned measures were planned to resolve all the issues.[249]

Pakistan Tahreek e Insaf (PTI): the general elections of 2008 gave uplift to the Pakistan Tehreek e Insaf. This was the first time that the party was acknowledged among the masses. It competed with the traditional winning parties. The popular slogan of Change and going against corruption gave the party significant number of voters. The manifesto presented by PTI was very concise; it highlighted all the major issues that needed attention. It shared its planning's to bring improvement in the areas of health, education, environment and most

[248] Altaf Ullah, Op.cit., pp. 98-99

[249] APNA Pakistan, "Manifestos' Analysis Report", Advocacy for Population and National Advancement of Pakistan", Available At: http://ccp-pakistan.org.pk/wp-content/uploads/2016/12/Manifestos-Analysis-Report.pdf Access on 25-5-2019

importantly the energy sector. It believed that the improvements in all these sectors will help the economy to prosper as well. They suggested that a decentralized policy shall be introduced to solve the current problems.

- WAPDA would take progressive steps that would bring efficiency in energy production, transmission, and delivery;
- Power tariff structure provides protection to weaker sections of society from an uncontrolled increase in utility rates and yet generates enough resources for future investment;
- Expediting rural electrification so that 80 percent of the villages have access to power;
- Encourage CNG use, introduce policy for conversion of all public commercial vehicles to CNG;
- Introduce a policy with time-bound objectives for the promotion of nonconventional sources of energy such as wind and solar power;
- Nuclear power program will be expanded; and in the oil and coal sector, encourage the local private sector in extraction and encourage joint ventures with foreign companies.

Pakistan Tahreek e Insaf (PTI): the party also highlighted its past performance in the manifesto like PML (N). Previously, the party ruled in KPK where it brought evident reforms in education and police department. The party also planted trees to a record level internationally. The main focus of the party rested upon providing social justice. It strongly carried the idea of accountability, merit and transparency in every institution of the country.

Furthermore, the party in planned to bring reforms in the public sector. It laid clear program to facilitate the health sector that was carried under the "Sehat insaf program". In future it intended to extend the current level of operation under the program. It believed that health of women should be secured in different stages of her life. This could be achieved by involving the private sector in the mainstream.

The party from its very beginning considered youth as an asset of the country. It formulated ways to employ them in the relevant fields. Thus, it suggested a model in which

the market needs shall be fulfilled with the required skill needed. To fulfil any gap the youth was encouraged to get qualification that is demanded by the market.

To resolve the challenges of energy the party suggested that the dependence on imported fuel should be reduced. Firstly, it suggested that ‘greener energy mix’ shall be relied upon to achieve ‘greener and sustainable’ energy. Mainly the country energy use should involve sources such as hydro power, wind and solar energy. It realized that the country has been heavily indebted due to the imports. Moreover, the ‘transmission and distribution losses’, theft of energy has even worsened the situation. This is also due to poor management that prevails in the system.

- System efficiency can rise by shifting away from rent seeking models
- Rural electrification can be completed through off-grid solutions and renewable solutions
- Conversion towards “power exchange”, permitting effective technologies to get precedency in dispatch
- Endure to upkeep the outreach and utilization of indigenous coal, primarily Thar coal
- Reinvigorate oil and gas exploration
- Magnify net matering and solar houses
- Expand net metering and solar houses.[250]

Although the manifestos provided by each party shows there ambitious planning to recover from the hard scenario, but the intentions alone cannot reap any benefit. It purely requires that the direction remains clear, the selection of fuel mix and the policy to be adopted should not be confused in any way. The government may adopt novel ways that are being adopted worldwide rather than the conventional ways such as producing energy through coal reserves. The manifestos circulated by the leading parties of the country have submitted promises whose results are still awaited. It clearly shows that the popular slogans used to reform the energy sector were just made to win the votes. In fact, the elements of political

[250] Pakistan Tehreek-i-Insaf (PTI), “The Road to Naya Pakistan– PTI Manifesto 2018”, (2018), Available At: http://insaf.pk/public/insafpk/content/manifesto Access on 25-05-2019

interference in the process of policy formulation and implementation have led to policy failures. These failures provide an evidence for governance failure. Corruption and nepotism have become a part of the intuitional culture. Consequently, it is difficult for the foreign investors and the local public even to trust the government and the projects they have initiated. The projects are carried out under so much dependence and reliance on foreign funding.

## II. Formal Institutions and Energy Governance of Pakistan

In this study energy governance is about the structure and performance of the institutions referred energy crisis of Pakistan. The study considers the role and the behavior of the political parties as informal institutional political perspective of energy governance; while the energy policies are considered the formal institutional political perspective of the same. In the state of Pakistan, the political parties and policies have provided an order and structure by aligning the decisions and actions in specific fashion. The energy crisis in Pakistan mostly secured the visibility in 1990's and in the two decades of the 21st century; therefore, the focused regimes are chosen from the same period.

**The idea is to analyze the Energy Decisions and Actions of energy governance affecting the energy security and crisis of Pakistan. The discussion delves into three regiments of; military regime, PPP regime and the Pakistan Muslim League regime.**

### A. Pakistan People's Party Regime and Energy Security /Energy Crisis of Pakistan

**Pakistan Energy-Policy 1994:** In 1994, government announced first national energy-policy designed to attract foreign investment in energy sector. In energy sector of Pakistan, this policy attracted substantial foreign investment. The policy was to achieve energy conversion and 13000MW energy generations through Independent Power Producers (IPPs). The policy extended immunity from surcharges and numerous taxes which included income tax, sales tax and custom duties on importing equipment by IPPs. It was decided to give bulk of tariff of US cents 6.5/KWh for WAPDA for buying energy. Moreover, for the first time an

agreement on fuel supply and power purchase was announced.[251]In 1994, total installed capacity was 11,000MW. In this capacity, hydropower provided 60% of energy followed by nuclear and thermal power gave 40%.[252] In 1994 power policy, new energy laws were adopted with the primary purpose to attract private investment in energy sector of Pakistan. Moreover, to standardized the measures for IPPs. In particular, this policy covered following measures.

1. Through this policy investors were free to choose the sources of fuel, plant generation site and technology.
2. This policy ensures the investors of return through state long term commitment owned power purchase utilities.
3. In order to minimize risks government provided the guarantee through series of agreements.
4. Long term agreements of (15-30) years regarding power purchase and fuel supply were concluded. These agreements work under the Implementation Agreement concluded with the government.
5. The government provided the protection against tax rates changes, force majeure and guaranteed foreign exchange for remittance.
6. Fund for the development of private sector energy helped with financial close of project.
7. This policy provided monetary benefits to investors in shape of all tax exemption such as corporate tax, repatriation of equity and profits, import duties and surcharge and foreign investors of project were protected from income tax.
8. This policy provided the ratio of favorable debt equity that required the equity of 20 % only. [253]

IPPs' foreign investment resulted in an unaffordable energy production and introduced circular debt.

[251]"Policy Framework and Package of Incentives for Private Sector Power Generation Projects in Pakistan", *Government of Pakistan*, (1994)
[252]Aneel Salman, "Natural Resource Planning and Management", *Lectures*, (2014)
[253]Government of Pakistan, Power Policy 1994, Op.cit.

**Hydro Energy-Policy 1995:** Foreign investment inflow increased by 93.3% mainly because of investments in energy sectors.[254] To attract more foreign investment in hydropower production, this policy took following measures.

1. On canal systems, investors were free to choose hydel plants and tributaries at any location and were free regarding opting any sort of equipment.
2. This policy focused on all possible hydropower plants up to 300MW.
3. It was mention in the policy that it is the responsibility of investor to look the revenues from the sale of energy because government will raise fund without any sovereign guarantee of reimbursement.
4. Out of total project capital cost minimum 20% equity investment will be required.
5. The policy said that private power generation companies will be exempted from all taxes like sale tax, income tax and other surcharges. It was also mention that there will be exemption 2% duties on the import of any machinery for these companies.
6. It was mentioned in the policy that after 25 years of operation, projects ownership will be transformed to Pakistan.
7. The policy said the Letter of Support and Letter of Interest will be the responsibilities of provisional government.

Major purpose of both 1994 and 1995 policies was to increase energy production capability to manage future energy crisis. Furthermore, through these policies, there was an attempt to attract foreign investment in energy sector.

**Policy for New Independent Power Private Projects 1998:** In 1998 energy-policy, the then government rationally revised 1994 policy. The policy was designed to meet expected demand between 19,000 to 25,500MW till 2008. On power tariff basis bidders, this policy gave exception to bidders from tenders through international competitive bidding. Selection was to be based on the minimum level tariff. It was decided that detail study would be prepared before the bidding. Like previous, this policy protected IPPs not only from risks but also provide exemptions from certain taxes and duties. It was expected that these power plants

[254] Ashfaque H. Khan and Yun-Hwan Kim, "Foreign Direct Investment in Pakistan: Policy Issues and Operational Implications", *Asian Development Bank*, (July 1999), p. 8

would create power market in Pakistan.[255] Unfortunately, no private investor invested through this policy. For new independent power private projects this policy covered following measures.

1. By July 2008, it was estimated that total energy demand in Pakistan will be in between 19,000MW to 25,500MW.
2. Until the year 2002-2003, it was expected to meet the demand on the basis of current energy generation capacity and will enhance capacity through public and private investment.
3. Until July 2008, on the basis of population growth, it was expected that the generating shortfall will remain in the range of between 5,000MW to 8500MW.
4. In the policy, it was clear that before inviting bids detail feasibility study is required.
5. It was mention in the policy that implementation of hydropower projects would be on the basis of Build-Own-Operate Transfer (BOOT).
6. At initial level the projects based on hydel and domestic coal will be considered.
7. IPPs will not be exempted from duties and taxes.

Through this policy, foreign banks were permitted to invest in energy sector through private power companies. This policy encouraged foreign investment and provided $506 million foreign investment. However, governments could not attract foreign investment in energy sector.[256]

**National Energy Policy 2010:** After the general election of 2008, mismanagement and weak policies become the cause of load-shedding. Country was facing long hours load shedding in cities and rural areas and mass protest. In response to ongoing energy crisis, Prime Minister Yousaf Raza Gillani announced an energy policy after three days energy conference held in Islamabad on 22 April 2010.[257]
Energy conservation remained the focal point of this policy in three ways.

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[255]"Policy for New Private Independent Power Projects", Government of Pakistan, (1998)
[256]Ibid., p. 14
[257]"Pakistan Energy Policy, "Laws and Regulations Handbook", *International Business Publications*, Vol. 1, (2007), pp. 57-58

1. Firstly, the production of energy through controversial Rental Power Plants was announced by the then Prime Minister of the country on 22nd April 2010.
2. Secondly, the existing public-sector energy-plants were rehabilitated.
3. Thirdly, investment by IPPs was envisaged in a short-term plan and a long-term plan to cater for the needs of energy of the country.[258]

It was a short-lived policy, given after the discussion with energy experts of the conference. In this policy, numerous attempts were made to privatize the energy sector. Despite several attempts, energy sector could not control energy crisis. After much criticism, the then government decided to nationalize energy sector. It issued a letter and directed energy corporations for enhanced energy production to manage the crisis.[259]

Pakistan is the first state to accept the agenda of SDGs 2030 through unanimous acceptance by the parliament. Pakistan joined the club of upper-middle-class states by prioritizing SDGs.[260] Ministry of Planning, Development and Reforms launched "Pakistan Vision 2025" to curb the challenge of sustainable development through SDGs. On 29 May 2014, National Economic Council approved "Pakistan Vision 2025". In this vision, there are seven pillars and all are aligned with agenda for sustainable development goals 2030. Thus, nation is committed to meet the challenges of SDGs.

**Policy for Development of Renewable Energy Production (2011):** In 2011, second renewable energy policy was announced by AEDB. It was second renewable energy policy with the aim to promote renewable energy. The focus of the policy was on wind energy, solar energy and small-scale hydro energy projects.[261] In 2011, it secured some interests in renewable energy projects' development on large scale energy production. However, due to

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[258]Government of Pakistan, "Guidelines for Setting up of Private Power Projects under Short-Term Capacity Addition Initiative", *Private Power and Infrastructure Board*, (2010), pp. 1-27

[259]"Pakistan Energy Policy, Laws and Regulations Handbook", op.cit., pp.57-58

[260]"Overview of SDGs", Available At: https://www.pc.gov.pk/web/sdg/sdgpak Access On 22-2-2018

[261]Syed Fareed Hussain, "Powering up: Pakistan's Push for Renewable Energy",(6 June 2007), Available At: http://www.scidev.net/en/features/powering-up-pakistans-push-for-renewable-energy.html Access On 22-2-2018

slow progress, only one 50 MW wind energy project became successful.[262] This policy supported energy production through wind energy, hydro power and biofuel-based technologies. For investments in such projects, this policy also gave tax-exemption on the import of machinery.

In 2011, renewable energy policy of 2006 was upgraded. It was a medium term/short term policy. Features of the policy were as following.

1. Major aim of the policy was to resolve the concerns of stakeholders by addressing the conflicts of policy.
2. Through this policy an effort was made regarding developing an understanding that the projects of renewable and alternative energy are cheap and require better return rate in compare with fossil fuel.
3. The focus of the policy was the development of non-electric renewable energy and Biofuels policy.
4. Through this policy incentives were expanded such as: Asian Development Bank loan guarantee fund, the fund for alternative energy, mandatory grid connection, coverage of the risk for partial resources, mandatory purchase requirement, for developers premium-based tariff return-rate for developers, small business program for an alternative of renewable energy (<10 MW) and mandatory grid connection.[263]

## B. Military Regime and Energy Security /Energy Crisis of Pakistan

**Energy Policy 2002:** The 1998 policy remained unsuccessful in attracting private investors. Therefore, the policy devised in 2002 was aimed at providing a new package of incentives. This was done mainly to attract private investors in energy sector and to make it affordable for consumers to purchase energy.[264] In the energy Policy of 2002, two public sector energy generation facilities, WAPDA and KESC, were integrated. The supplying of energy to all Pakistan came under WAPDA, except for Karachi which was under KESC.

[262]Nauman Bhutta, "Wind Power Projects and Role of Government", *World Wing Energy Conference,* Energy Wing, Planning Commission, (2008), pp. 24-26

[263]"Alternative and Renewable Energy Policy", (2011) Available At: http://www.iea.org/policiesandmeasures/pams/pakistan/name-38076-en.php Access on 22-2-2018

[264]"Policy for Power Generation Projects", *Private Power and Infrastructure Board*, (2002), pp. 1-27

Total energy production capacity was 17,664MW in which 9,949MW was owned by WAPDA, KESC owned 1,756MW, PAEC owned 437MW and 5,522MW was owned by IPPs.[265] This energy generation policy encouraged both public and private partnership in energy related projects. The structure of the policy was investor friendly. Instead of upfront tariff, Competitive bidding was announced in the policy. Federal government were responsible of above 50MW and above capacity projects. Provincial governments were for projects less than 50 MW. This policy welcomed the proposal on raw sites without any feasibility study. The policy focused on the development of energy projects, use of domestic resources especially coal and other renewables. The objectives of the policy were as following.

1. For energy production, the purpose of the policy was to provide sufficient capacity at low cost and also avoid its shortfall.
2. This policy promotes the exploration of domestic reserves which includes human resources, renewable resources, local engineering participation and capabilities of manufacturing.
3. In this policy it was ensure that the interests of all stakeholders should be secured and there should be a win-win situation for all.
4. To be attuned to secure the atmosphere.[266]

The policy targeted, in the primary energy, a 3% increase in total energy mix of the country utilizing the energy produced by the use of renewable sources, by 2010. To develop the technology for the production of energy based on renewable sources, the government allocated, out of the budget for annual development, a share of 2%, specifically. It was also aimed that, within next 30 years, all localities, connected to the national grid, shall be reserved for renewable energy resources.

To achieve the goal that aimed at increasing the energy production capacity, government strained to encourage local and foreign investment. Subsidies were minimized to implement tariff rationalization. To minimize the cost, competitive bidding was suggested. In

[265]Ibid., p.1
[266] Ibid., p. 10

Pakistan, various energy reforms were introduced but most of these were implemented partially due to mismanagement and on other relevant grounds. This implementation issue became the cause of the downfall of energy sector and the opportunities which were like to be taken were missed through these energy policies.[267]

**Energy Security Action Plan (2005-2030):** In 2005, government approved the Energy Security Action Plan (2005-2030). The plan focused on the increase of energy supply by the use of an optimum combination of all resources. The resources include oil, coal, gas, hydel and renewable energy resources like solar and wind energy.[268]

**Table-4.1 Energy Production Plan of Pakistan (2005-2030) MW**

| Year | Hydel | Oil | Gas | Nuclear | Renewables | Coal | Total |
|---|---|---|---|---|---|---|---|
| 2005 | 6,460 | 6,400 | 5,940 | 400 | 180 | 160 | 19,540 |
| 2010 | 7,720 | 6,560 | 10,800 | 400 | 880 | 1,060 | 27,420 |
| 2020 | 19,990 | 7,160 | 30,910 | 2,800 | 3,150 | 8,260 | 72,270 |
| 2030 | 32,660 | 7,760 | 83,760 | 8,800 | 9,700 | 19,910 | 162,590 |

**Source**: Zia Mian and Abdul H. Nayyar, "Pakistan and the Energy Challenge", *Princeton University*, Available On: https://www.princeton.edu/sgs/faculty-staff/zia-mian/Pakistan-Energy-Challenge2.pdf, p. 542, Access on 12-07-2018

Major target of the plan was to manage energy crisis of Pakistan, at most by the end of 2030. Derived in 2005, when the installed capacity was 19,786 MW, it was aimed to promote the use of alternative energy resources while additional 8,800MW of energy was to be produced from nuclear energy plants. This plan presented medium and long-term policies. The share of coal will increase maximum. In the plan, it was suggested that fuel mix should be inclined towards nuclear, coal and renewable resources.

[267]Ziad Alahdad, "Pakistan's Energy Sector: From Crisis to Crisis – Breaking the Chain", *Pakistan Institute of Development Economics*, (2012), p. 32

[268]"Review of International Energy Policies and Actions and The Last Practice in their Environment Evaluation and Strategic Environment Assessment", *Environment Protection Department*, (November 2007), p. 1

It was anticipated that the country would soon fall short of its energy requirements. This was based on the prediction that the utilization of energy will increase 7 folds. In order to cope with the increasing demand of energy, it should be significant for the country to keep sticking to the use of coal, nuclear and renewable resources. The share of coal was planned to be increased by 13% till 2030. It proposed detailed policy measures with a new approach: Full-Scale Deregulation to reform governance, along with the phasing out of many subsidies, was also introduced in the program.

The aim was to reduce dependency on imported fuel for the production of energy and with an increased reliance on indigenous resources.[269]

To reduce outflow of foreign exchange, government would increase exploration of both oil and gas along with other sources.[270] Unfortunately, this plan could not meet the required targets. The process of implementation of the plan was derailed due to various technical incompatibilities and financial constraints.

**Pakistan's Renewable Energy Policy (2006):** There is a variety of sources to produce energy ranging non-renewable to renewable energy sources. As per renewable energy sources, energy may be produced from wind, solar, biomass and geothermal etcetera. By the use of these sources, energy may be produced with zero emission of GHGs. Irrespective of political or geographical constrains, these sources are universally available. Pakistan is blessed with huge renewable energy reserves.

In 1994, 1998 and 2002, new energy policies, based on renewable energy sources, were introduced. The energy policy of 2002 promoted the use of indigenous energy reserves, regarding renewable energy. The objective of this policy was to produce 500MW of renewable energy (Non-hydro) till 2015 and approximately 1000MW till 2020.

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[269]Josh and Mak Team, "Pakistan's Energy Security Plan (2005-2030)", (8 January 2014) Available At:www.joshandmakinternational.com,"https://joshandmakinternational.com/pakistans-energy-security-plan-2005-2030/Access On 22-9-2018

[270]Irshad Ansari, "Energy Security Action Plan: Power Crisis to End by 2030", *The Express Tribune*, (15 June 2011)

In 2006, energy production policy was the first energy policy of Pakistan which was based on renewable energy sources. The purpose of the policy was to promote the projects which were to utilize renewable energy sources. The purpose of the policy was to include 10 % share through renewable energy in energy mix of the state by the end of 2015. Through this policy, government was focusing on hydro, solar and wind energy projects. This policy was basically divided into three phases: short term, medium term and long term.[271] The discussion on the features of this policy goes as under:

1. This policy encouraged the investment of private sector in following categories:
   a. Independent Power Projects, for power sale to national grid
   b. Spillover Power Projects, both for personal use and to sale for utility
   c. Captive Power Projects, both for personal use and for dedicated uses
   d. Isolated Grid Power Projects, covering small and stand-alone projects
2. For these projects, there will be no requirement of any Letter of Intent (LoI) or Letter of Support (LoS) to be approved or getting the Implementation Agreement (IA) signed from government.
3. The purchasing of energy for NTDC, on the qualification of the projects based on renewable energy production, is compulsory.
4. This policy not only allows but also attracts investors to produce energy through renewable resources from one location and receive same amount of energy for personal uses anywhere from the grid at the cost of his own production and transmission.
5. This policy allows net billing and metering with the purpose that a producer can sell extra energy and receive required energy from the grid any time and may adjust payments on net basis. This system will facilitate small scale generation, dispersed generation and utilization of optimum capacity of installed system.
6. This policy deregulates and declines small level energy production through the utilization of renewable resources.
7. In this policy, tariff determination principle was simplified and made transparent.

[271]"Policy for Development of Renewable Energy for Power Generation: Employing Small Hydro, Wind and Solar Technologies", *Government of Pakistan*, (2006)

8. This policy protected the investors from the risk of the variability of resource.

It was purpose of the government to open the doors to private investors to induce them to make investment in energy sector of Pakistan.[272]

**National Policy for Power Co-Generation by Sugar Industry (2008):** Among many crops in Pakistan, sugar can is one of them. Sugar industry contributes 20.9% in GDP and provides 43.5% employment.[273] In Pakistan, the capacity of energy production of 83 sugar mills through Bio waste is 3000MW. In 2008, when energy crises were on top, for co-generation of energy, government declared national-policy with the assistance of sugar industry. The key purpose of this policy was to encourage private sector investments to manage energy crisis. In this policy, projects of co-generation relied upon pulp produced in sugar plants. From November to February, during cane crushing season, it was used as main fuel and from March to October local or imported will be used. For energy plants, a thirty years policy, with levelized tariff, was offered. It will have 60MW capacity or more, with the least thermal efficiency of 28%.

The discussion on the said policy goes as under:

1. The incentives available for power co-generation units of sugar mills will be similar as available for Independent Power Plants (IPPs) under 2002 energy generation policy.
2. NTDC or DISCO will purchase produced energy of sugar mills on approved rates of NEPRA. Agreements regarding sale and purchase will remain valid during the life of co-generation units. The terms and conditions of the agreements with sugar mills will be same as agreement sign with IPPs.
3. The consumption of imported/local coal and bagasse will be based on limitless interchange, internally, of the requirement of plant.
4. For the construction of co-generation projects, there will be no need of feasibility study, pre-qualification and letter of interests (LoI) from Private Power & Infrastructure Board (PPIB). The projects will be constructed on Fast Track Basis and

[272]Ibid
[273]"Economic Survey of Pakistan 2014–15", *Ministry of Finance*, (2015)

PPIB will issue a Letter of Support (LoS) to sugar industry after determination of upfront tariff by NEPRA.

5. After issuance of Letter of Support, power co-generation plants of selected sugar mills will be constructed within the period of 36 months. Basic structure of the plants may already be placed before issuance of LoS.
6. Sugar mills will be responsible for making all sort of arrangements like procurement of machinery, purchase of land and bank financing etcetera.
7. It was decided that these plants will be treated as separate entity for the purpose of tax and not as the part of sugar industry.
8. For energy production, tariff rules and guidelines of IPPs would be followed.[274]

## C. Pakistan Muslim League (N) Regime and Energy Security /Energy Crisis of Pakistan

**Pakistan Vision 2025:** The key purpose of the vision is to ensure uninterrupted supply of affordable and clean energy for all fabrics of society. Pillar IV (Energy, Water and Food Security) is in-lined with SDG-7. Through this pillar of Vision, government recognizes that sustainable, affordable and clean energy is fundamental for sustainable economic progress and development. In this respect, the vision has identified following 10 goals:

1. The gap between demand and supply of energy will be eliminated by 2018. Also, that, by 2025, 25000MW will be added in the system to meet future demand.
2. Based on economic feasibility, indigenous resources, environmental impact and risk management, the energy generation mix will be optimized among furnace oil, nuclear, coal, hydro, wind, bio-mass, solar and natural gas resources.
3. Two key hydro-power projects- Diamer-Bhasha and Dasu dams- will be completed.
4. 6600MW Gaddani Energy Park will be completed and the utility of the potential of Thar coal will be maximized.

[274] "National Policy for Power Co-Generation By Sugar Industry", Private Power & Infrastructure Board, Ministry of Water & Power, Government of Pakistan, Pursuant to Decision of the Economic Coordination Committee of the Cabinet (the ECC) in Case No. ECC-169/13/2007 dated November 13, 2007 approved "National Policy for Power Co-Generation by Sugar Industry" (the Co-Gen Policy).

5. The use of Pakistan's extensive indigenous resources for alternative energy will be maximized.
6. New nuclear energy generation plants will be completed.
7. By investing in transmission and distribution network, distribution capacity will be improved and line losses will be reduced. Also, effective enforcement control mechanism will be maximized.
8. The poor performance of the sector through institutional fragmentation will be addressed.
9. Management of demand and conversion, to guarantee prioritization in allocation and waste elimination, will be concentrated.
10. Institutional reforms with improved regulatory mechanism for improving efficiency and transparency will be announced.[275]

**Foreign Investment is one of the major determinants in the development of energy policies of Pakistan. Particularly in the Post-Cold War period. The reasons were: the increased demand of energy because of socio-economic globalization, decrease in the official assistance to the developing countries from the developed countries in case of Pakistan the US financial aid to Pakistan, and the interest of the multinationals to invest in the energy sector of Pakistan.**

Foreign investment may be defined as "Private capital inflow from a parent firm to an outside location of the parent's firm home nation."[276] Attractive policies of host nations and modified perceptions increased foreign investment flow from industrialized states to underdeveloped countries. From 1980 to 1999, foreign investment inflow towards developing nations has risen from $132.95 billion to 1438.48 billion.[277]

Over the last decade, pace of foreign investment grew rapidly. Accordingly, in early 1990s, government of Pakistan introduced policies based on market-based economic reforms.

[275]"Pakistan 2025 One Nation-One Vision", *Planning Commission*, Available At: https://www.pc.gov.pk/uploads/vision2025/Pakistan-Vision-2025.pdf Access On: 25-12-2018 p.58
[276]Shahid Raza, Adnan Khan and Yasir Arafat, "CPEC as Driver of Foreign Direct Investment (FDI) in Pakistan: An Opportunity to Reshape the Economy", *Centre of Excellence for CPEC*, working Paper No. 27, No. 2, (2018), p. 3
[277]Zahir Shah and Qazi Masood Ahmed, "The Determinants of Foreign Direct Investment in Pakistan: An Empirical Investigation", *The Pakistan Developmental Review*, Vol. 42, No. 4, (Winter 2003), p. 697

The policies started to take hold. After that, governments adopted liberal investment and trade policies. Governments provided various fiscal and trade incentives to foreign investors. These incentives included credit facilities, tax concessions, easy control of foreign exchange and tariff reduction. In 1990s, polices were further liberalized and governments opened the sectors of telecommunication, energy and agriculture for foreign investment. In contrast to other countries, fruitful results were not achieved. It was due to inconsistency in policies and rapidly changing political environment.[278]

Traditionally, Pakistan is an in-taker of foreign investment. Foreign investment did not play any appreciable role generally in economic development and particularly in the development of energy sector. In Pakistan the major focus was to increase energy production by providing investment friendly environment to attract foreign investment.[279]

National energy policies of 1994, 1995, 1998, 2002, 2013 and 2015 have been made to attract foreign investments to support energy sector.

**National Energy-Policy 2013:** In 2013, after general elections, newly elected government announced national power-policy with varied goals to be achieved by the end of 2017. Focus of the policy was to shift energy mix of Pakistan towards low-cost sources by attracting foreign investment. For that, this Policy covered following measures: -

1. The focus was on installment of new power generation plants to reduce gap in demand and supply.
2. The cost of generation was reduced from 0.12/KWh US dollar to 0.10/KWh US dollar.
3. The losses of distribution and transmission were reduced from 23% to 16%.
4. The bill collection from consumer was increased from 85% to 95%.
5. It was announced that by the end of 2018, 16,000MW energy will be added.
6. Policy goal was to enable Pakistan to energy generation capability to manage energy demand sustainably.

[278]Anjum Aqeel and Mohammad Nishat, "The Determinants of Foreign Direct Investment in Pakistan", *The Pakistan Development Review*, Vol. 43, No. 4, (Winter 2004), p. 651

[279]S. M. Mazhar Hasan, "Private Foreign Investment in Pakistan During 1990s", Pakistan Economist, (June 2000), Available At: http://www.pakistaneconomist.com/issue2000/issue23/f&m3.htm Access on 22-05-2019

7. In order to meet growing demand, the focus was to create sense of responsibility and culture of conservation among people.
8. Through affordable power strategy, the plan was to ensure the generation of affordable and inexpensive energy for local, commercial and industrial usage.
9. The goal of supply-chain strategy was to minimize pilferage and adulteration in supply of fuel.
10. Regarding energy production, the goal of the policy was to promote international standard efficiency in production of energy.
11. Regarding transmission strategy the goal of the policy was to develop a cutting-edge transmission network.
12. To minimize distribution losses the focus of the policy was to minimize inefficiencies in the distribution system.
13. To control financial problems, it was mention that the focus will be to minimize financial losses across the system.
14. In order to govern the policy, the goal was to develop cooperation among involved ministries in energy sector by improving governance. [280]

The goal of the policy included growth of energy to meet growing energy needs and promote the culture of energy conversion. Moreover, the policy envisaged upfront tariff and competitive bidding to lower the cost of energy. In this policy a strategy was adopted to focus foreign and local investment. Local and foreign investors were invited for investment on small and medium size hydropower projects.

**Energy Policy of 2015:** In 2015 power-policy, the then government enhanced the incentives for investors and encouraged the use of indigenous resources to reduce power and supply gap which was hovering around 6000MW. The purpose of the policy was to increase low-cost power generation capacity by focusing on protection of environment. This policy failed to cover overall energy sector and focused only on energy which was the domain of water and power ministry.

[280]National Power Policy, *Private Power and Infrastructural Board*, Government of Pakistan, (2013)

This policy gave great importance to maximum use of raw hydropower sites and cheap and clean resources. Simultaneously, government encouraged public private partnership (PPP) and offered incentives on the installment of new power projects.[281] To support public private partnership, government took following measures.

1. Corporate income tax, turnover tax, sales tax and withholding tax was exempted.
2. Only 5% duty tax was implemented on import of plant and other equipment.
3. Government provided guarantees regarding the power purchaser and provinces.
4. It was mentioned in the policy that for hydro power projects water usage charges will be paid @ RS.0.425/KWh to the provisional government under which jurisdiction the project was installed.
5. Government will be responsible to provide guarantee for payment obligations and all tariff payment will be made in Pakistani currency.
6. The then government was responsible to provide protection against Political Force Majeure, amendment in law, duties and Taxes.[282]

In Pakistan, all policies were developed with serious efforts to attract foreign investments. The problem was on the side of implementation mechanism and absence of energy modeling exercises. In energy policies, despite favorable environment, Gross Fixed investment ratio remained stagnated. Public sector faced setback due to increase private investments. Thus, private sectors investment remains failed to counterbalance the downfall.

Countries with high inflow of foreign investment promote strong fundamentals like exchange rate stability, GDP ratio and low inflation. Pakistan couldn't promote these factors to attract foreign investment. The incredibility, caused by the row with independent power projects, is the greatest hindrance in the way of foreign investment. Though the credibility is settling in, the stalemate in the units like Hub Power Project remains as yet. Foreign investors are unable to digest the frozen foreign accounts and violation of Terms and Conditions.[283] Graph 4.1 shows Inflow of foreign investment in Pakistan from 1991 to 2003. For the success

[281]Nayyar Hussain Mirat, Op.cit., p. 122
[282]"Power Generation Policy 2015", *Ministry of Water and Development*, (3rd April 2015)
[283]S. M. Mazhar Hasan, op.cit.

of these policies, it was important that there should be a great focus on the implementation process by focusing on the depletion of internal energy resources. Moreover, environment concerns and affordability should also be focused with true spirit.

**CPEC: An Exponential Foreign Investment in Pakistan:** In a country, climate of foreign investment indicates the interests of foreign investors. This climate builds confidence among investors on investment security and economic policies. Foreign investment contributes to economic development by increasing economic activities. It supports economic development through various means like the provision of employment, innovation of new technology and etcetera.[284] Energy crisis and security problems affect the flow of foreign investment and ultimately national economy.

Slow rate of capital formation and high saving investment gap has put GDP growth of Pakistan against potential crisis. Two key sources- public investment and foreign investment- may help fill this gap. In Pakistan, the burden of huge public debt has made public investment limited while foreign investment is sluggish due to potential energy crisis, poor infrastructure connectivity and insecure business environment.[285]

In this scenario, $62 Billion Chinese investment is a highway leading out of chaotic energy crisis. CPEC is foreign investment, based on commercial contracts. They are in-line with GoP standards. China is financing on equity basis. Commercial loans are sanctioned by China Development Bank and its relevant commercial bank on 5% rate. Debts CPEC would be borne by investors of China.[286]

There are four dimensions of this foreign investment: energy, infrastructure, Special Economic Zones (SEZ) and Gwadar. These dimensions are combined to form CPEC 1+4 portfolio. CPEC boosts inflow of foreign investment for Pakistan. From July 2017 to October

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[284]Saifullah Malik and Qaisar Ali Malik, "Empirical Analysis of Macroeconomic Indicators as Determinants of Foreign Direct Investment in Pakistan", *Journal of Business and Management*, Vol. 7, No. 2, (January-February 2013), pp. 77-82

[285]Ibid., p. 19

[286]"Embassy of the People's Republic of China in the Islamic Republic of Pakistan", Latest Progress on the CPEC (29-12-2018) Available at: http://pk.chineseembassy.org/eng/zbgx/CPEC/t1626097.htmAccess on 29-12-2018

18, Pakistan received $939.7 million foreign investment, a 74% increase, an extraordinary achievement. In October 2017, inflow of foreign investment was $277.7 million to $115.3, which was in October 2016. According to Board of Investments (BOI), China, the leading foreign investment country, invested $631.7 million. In FY2016-17, Chinese foreign investment was more than 224.6%. In November 2017, Pakistan received $207 million net foreign investment out of which Chinese share was $206 million.[287] Through CPEC, China invested major portion of investment in energy and infrastructure sector. An improved infrastructure will encourage investments by private sector, providing it better business opportunities.

Energy sector of Pakistan received major share of investment followed by infrastructural development, economy and communication sector. During first four months of FY2018, inflow of foreign investment in energy sector was raised from 125.4% to $422.4 million. During the same span of time, foreign investment fetched by construction sector was $177.0 million as compared to early year $31.4 million.[288] In coming years, provided that CPEC projects remain on track, brighter aspects are expected.

## III. Commissions and Omissions of Energy Governance of Pakistan

The ontological perspective in this section of the study is 'Bad Governance. Bad governance is the unfavorable relationship between those who govern and those who are governed as a consequence of decision-making. ... Bad governance collectively encompasses governance in government and corporate settings.'[289] The progress with the energy governance of Pakistan on energy development is uneven is primarily owing to the malaise in governance.

A. Commissions: The committed energy decisions and actions; caused the energy crisis in Pakistan e-g, IPPs Project

[287] Jia Yu, "CPEC is not a Gift", *CPEC Summit* (2018)
[288] "CPEC Boost Foreign Direct Investment by 74%", *Daily Times*, (17 November 2017)
[289] Muhammad Ali, "Governance and Good Governance: A Conceptual Perspective", *The Dialogue*, Vol. 10, No. 1, (2015), p. 10

B. Omissions: The omitted energy decisions and actions; caused the energy crisis in Pakistan e-g, Kalabagh dam

Energy crisis management is intertwined with institutions and energy policies. Energy policies focuses sufficiently available energy sources to meet energy needs. This study assesses the efficacy and impact of energy policies by highlighting the policy experiences causing energy crisis in Pakistan. It is found that the energy policies were developed with less focus on affordability and environment. In order to utilize the potential of CPEC in Pakistan, this research identifies two perspectives of energy crisis: The Commissions in Energy Policy making of Pakistan e-g, Independent Power Producers (IPPs), and Omissions in Energy Policymaking for example in the last 45 years no policy was made to construct the bigger dams like Tarbela[290] and Mangla.[291] The role of each of perspective is significant in order to utilize CPEC and bridge the gap between energy demand and supply in Pakistan.

## A. Commissions (Committed Decisions and Actions) of Energy Governance of Pakistan

Pakistan is facing energy crisis, the offspring of inadequate energy policies. Energy policies of the past government promoted problems instead of solutions. Energy institutions adopted short-term measures, ignoring long term institutional vision. With the passage of time, it worsened the situation. Globally, states are turning to renewable energy resources. While, under present energy policies, Pakistan is ruining both mental calm and money on expensive furnace oil for energy. Under these policies, Pakistan is not only going under financial crisis but also increasing the amount of oil and gas in energy mix. It is making the environment hazardous for health.

The study found following commissions in energy policies.

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[290]Terbela Dam: In 1976, construction of Terbela Dam was completed as a component of Indus Basin Projects. Total cost of the project was $1.497 Billion. The project was funded by World Bank and International Development Association (IDA).

[291]Mangla Dam: In 1967, construction of Mangla Dam was completed. Total cost of the project was $1.473 Billion and was financed by World Bank and Asian Development Bank

**Independent Power Producers (IPPs) Projects:** In Pakistan, IPPs started their commercial operation after the recommendation of 1994's power-policy. These IPPs brought disastrous impacts in energy sector of Pakistan. This disaster was caused by incentive based and lucrative nature of energy policy in which private sector was invited to invest in energy sector. The apparent reason behind inviting IPPs, in the form of heavy foreign investment, was to manage energy crisis. IPPs themselves and the purchasing of energy from them added to existing problems of energy. Also, energy sector was already in financial crisis and lack of funds gave space to IPPs for investment. This 1994, energy-policy wasn't properly contemplated and as a consequence, it brought expensive energy in the country. On one side, IPPs were allowed to use oil for production of energy and on the other side they charged high tariffs. Among the rest, while singing energy agreement, the capacity of the production of the plants, according to future energy demands, was not considered.

IPPs have their own way of energy production. IPPs participate in 30% of total energy production. Substantial incentives were offered to IPPs and private investment was attaracted which brought 4,100 MW of energyproduction capacity to the grid.[292] IPPs play significant role in energy production yet, due to shortage of working capital, they are producing below their capacity. It is because, a huge amount is receivable from PEPCO.[293] The energy-sector was highly affected by the inclusion of IPPs. There are certain reasons behind all this. IPPs are bound with no international binding processes, plants commissioning timings are untargeted and their locations are awkward, being far away from main grids. IPPs brought an added burgeon of issues along with the energy, produced though furnace oil. Thus, the energy produced by IPPs is a crisis in itself, instead of a relief.[294]

Institution of NEPRA lacks in process of energy regulation. In carrying out the desired function effectively, NEPRA lacks administrative governance and overall institutional autonomy which shows its institutional inability. It is unable to provide a reasonable pricing mechanism and supervise the sector. Institutional weaknesses of 80s and 90s continues to

[292]Rashid Azia and Munawar Baseer Saeed, "Pakistan's Power Crisis: The Way Forward," *Unites States Institute of Peace*, (Special Report), pp. 3-10
[293]"An Overview of Electricity Sector in Pakistan", *Islamabad Chamber of Commerce & Industry Report*, P. 6
[294]Arshad H. Abbasi, et.al., op.cit., p. 19

worsen energy sector. For its development, none of the governments made serious efforts to manage it.[295]

In energy-sector, purpose of Integrated Energy Policy (IEP) is to harmonize energy policies and plans. Its major aim is to develop coordination among different departments of energy to achieve national socio-economic objectives.[296]In energy sector of Pakistan, adhoc policies and decisions are responsible for non-seriousness in policy formulation and decisions. After 1994, various energy policies were formulated and implemented to maintain accessibility, certainty, affordability and sustainability. However, none of the objectives was achieved due to non-serious attitude of policy makers. Most of these policies focused on short-term energy issues management, avoiding major long-term approaches for energy crisis management. For example, energy policy of 1994 was formulated to manage energy crisis through IPPs. In short-term, policy became successful to achieve its objective but in long-term it remained a failure in bringing positive and sustainable imprint. As a result, at present, Pakistan is facing the worst results of that short-term success.

Two reports, one conducted by Haigler Bailly Pakistan and the second funded by US for energy distribution improvement program were presented. According to these reports, because of poor governance and mismanagement, energy sector is losing 391.6 billion rupees per year. It also causes a loss of 1500MW production capacity for which estimated cost is 135 billion rupees. These reports also say that energy sector is facing 22% distribution losses, 8% technical losses and 2% administrative losses. The reports show that 10% of these losses may be lessened with the saving of 60 billion rupees per annum.[297]

All developing economies suffer from inefficient institutional framework. In institutional vision of Pakistan, the focus of energy production is on renewable energy sources. Nonetheless, this vision does not circumvent implementation process. Institutions can't indicate as to how and when self-reliance would be achieved. Financial constraints and inadequate foreign investments are a hurdle in utilization of indigenous resources. Energy

[295]Afia Malik, op.cit., p. 32
[296]Ziad Alahdad, op.cit., p. 6
[297]Ibid.

sector of Pakistan suffers the absence of centralized decision-making body which plays centralized role. In this sector, there are different energy regulatory authorities like NEPRA, WAPDA and KESC. They have their own regulatory system.

**Corruption in the Centralized Energy System:** Corruption control in centralized energy system of Pakistan in one of the omissions. In energy system, it is a common belief that energy policy makers for their personal interests pose enormous threat to energy system. For the purpose, they prefer inappropriate projects over extremely essential ones to approve investments for their personal benefits. Such actions portray their political motives like corruption or other frauds. Energy sector always remained a source of worry for general public for monetary issues like privatization of KESC, IPPs program and the like.[298]

In energy sector, besides non-recoveries, theft and kunda system, there are numerous islands of corruption. The list of corruption includes debauchery in material supply, purchase and installment of transformers and meter workshops etcetera. Power theft is also a type of corruption which is done under the very eyes of energy sector officials. The element of corruption exists in the privatization of KESC. It was sold to private sector in cheaper prices. In order to judge the allegation of corruption in privatization of KESC, Transparency International showed its willingness. However, concerned authorities didn't provide it with the real document of privatization.[299] It is a dilemma that if floodgates of energy are opened, load shedding cannot be controlled. If it happens, it would eventually devastate national economy.[300]

It is a fact that national energy policies are crucial for national energy policy making. In order to address the growing demand of energy and to ensure its smooth supply, governments formulate energy-policies. Energy policy making and its implementation has various enduring features which hinder its implementation. Energy policies of Pakistan are flawless. Energy experts and energy institutions are well aware of present energy environment. Since the start of energy crisis, there certainly was no shortage of effort to

[298]Afia Malik, op.cit., p. 32
[299]Moosa Kaleem, "Strapped for Cash", *The Herald,* (May 2008), pp. 88-89
[300]Khaleeq Kiani, "Corruption Hampers Efforts to End Power Cuts, Admits Minister", *Dawn,* (24 October 2018)

promote energy efficiency through energy polices. The lack of coordination among different departments, ministries and government, regarding management of energy crisis, have never been studied under a single focal-point. Each sector has its own independent policy and is pursuing it to meet the demands. The major cause behind severe energy crisis is the lack of governance in energy sector. Authorities are unable to manage the gap between demand and supply. Mismanagement made independent and private power producers to shut down their power plants.

Pakistan is a developing state with massive untapped energy reserves. In energy crisis of Pakistan, problems lie not on the side of policy or policy making but on the side of its implementation. National leadership has developed no constant and long-term energy policy implementation program. Institutions formulate policies with poor enforcement mechanism. They are incapable of managing energy crisis. Thus, country is facing huge mismanagement with no foreseen solution. Institutions need a true spirit to properly enforce energy policies.

## B. Omissions (Omitted Decisions and Actions) of Energy Governance of Pakistan

In the Pakistan Constitution, 25 articles deal with water management for future generations. Globally, policy makers resolve water issues by developing effective policies. In Pakistan, dealing with water issue is very difficult for it is the subject of provinces rather than federation. However, on provincial level, there is no uniform policy to deal with water problems. Pakistan has only one large river basin which is a key water source to serve all its federation units. No past government made any policy to deal with the issues that are barriers in the way of construction of Kalabagh Dam.[301] The construction of two dams has become an issue of conflict among political parties. Conflict and clash over construction of Kalabagh Dam and Mohmand Dam is much visible among political opponents instead of common man. Former President Ayub Khan was interested in the construction of dams and then, fifty years

[301]Zafar Mahmood, "Searching for Solution of Water Issues-Options and Possibilities", Available at http://www.wapda.gov.pk/index.php/about-us/wapda-articles/kalabagh-dam Access on 27-05-2019

later, President Musharraf did the same but certain reasons didn't let it happen. The commissions of energy policy that kept the construction of a large dam are:

**Kalabagh Dam:** For many decades, the controversy over the construction of Kalabagh dam has been going on. Those who favor its construction state that along with giving massive benefits of irrigation and flood control, it will provide an additional opportunity for the production of energy. It will definitely improve living standard of a common man by providing massive water for irrigation and other purposes and thus overcome the issue of water shortage and also help meet energy crisis by producing massive energy for energy mix of the state. The construction of both dams will ensure the safety of people and lands from floods.

Hurdles in construction of Kalabagh dam lie in policy making. No policy was made to ensure the building of this dam for future safety. Kalabagh dam would provide affordable and clean energy. The cost of thermal unit will be 16 rupees per unit and Hydel 2.5 to 3 rupees per unit and it will produce 3,600 MW energy. It will reduce 30%-line losses and will save $4 billion per year. In 1953, soil investigation and site exploration of Kalabagh dam was started with the cooperation of World Bank. In June 1987, estimated cost of the project was $2,650 million which reached $6,124 million in July 2005.[302]

It was expected that its construction will start in 1987 and end in 1993. Unfortunately, construction could not be started due to absence of policy mechanism and some political reasons. Governments could not develop consensus over its construction. Former President G. Pervez Musharraf was keenly interested in its construction. However, MQM and ANP protested against it. PPPP is also not in its favor. Nevertheless, PTI and PMLN seem neutral over it.[303]

People who oppose the construction of Kalabagh Dam have the view that it will render one to two hundred thousand people homeless and they will be displaced. Government of

[302]Muhammad Israr Khan, "Feasibility Study of Kalabagh Dam Pakistan", *Life Science Journal*, Vol. 11, No. 9, (2014), p. 468
[303]Ibid. p. 469

KPK has the phobia that it will submerge Nowshera and its surrounding areas. Similarly, government of Sindh is of the view that it will disturb the flow of water for their farmers. Moreover, assemblies of three provinces have voted against the construction of Kalabagh Dam.

Political controversies over dams are not a novel thing for these started with the proposal of the construction of dam. Political leaders are against the construction of dam and they are mobbing themselves against it. Even in 1985, a political leader of KPK threatened of blowing the dam with a bomb, if constructed.[304]

For energy production, Pakistan, like any other country, is relaying on dams for it does not have enough dams for energy production. There is a great number of dams built by Indian government to manage the crisis of energy but on the side of Pakistan, political parties are doing everything they can do to stop the construction of dams. A number of dams, like Kalabagh Dam, is facing the delay due to the tussles among provinces. Caused by the procrastination of the construction of Kala Bagh Dam, the machinery of worth $9 million is now functionless.[305]

Kalabagh dam reflects policy crisis. Policy makers, intentionally, do not formulate a single policy in the favor of its construction. Policy crisis which leads to transparency issues always remained a serious factor in its construction. The problems or hurdles raised by political orthodox of KPK and Sindh, the technical specifications and the ground realities undergo numerous revisions. For political benefits, these orthodox promoted misconceptions that it will benefit Punjab on the expense of Sindh and KPK. Such steps stopped political leadership from developing consensus of policies in the favor of the project. This commission is still posing a great threat to the nation.

**Mohmand Dam:** In the political history of Pakistan, energy sector kept facing misplaced priorities. In this list, a major one is the focus on thermal energy, sidelining hydro-energy. The policies of previous governments focused on thermal energy plants and road projects. They were reluctant to invest on hydel energy projects. They ignored the fact that

[304]"Pakistan: The Worsening Conflict in Balochistan", *International Crisis Group*, (2006), p. 25
[305]Sumaira Nasir Durrani, "Energy Problems and Opportunities", *The Frontier Post*, (18 April 2012)

water problem is severe and directly linked to food security. In 1995, Pakistan introduced its first hydropower policy. Similarly, in 2002 and 2013, second and third hydropower policies were introduced. Governments have been formulating hydel based energy policies for affordable and clean energy. Policies, if not implemented practically, come to nothing and become the cause of energy crisis.

In the history of country, first political government of PTI showed its interests in the construction of Mohmand Dam. The live capacity of the dam is 0.67 Million Acre Feet (MAF) with gross capacity 1.9 (MAF). It will provide 800MW energy with annual energy production of 2862 GW/h energy.[306] The initiative of present government in collaboration with Supreme Court is mobilizing the masses for moral and financial support. Total cost of the dam is $3 billion and its construction will take six years. Eight years ago, the cost of the project was $1.2 billion and now it is doubled. It shows commission of policy making regarding not only the construction of a big dam for energy but also for flood control and irrigation.[307]

Since independence, Pakistan faced lack of interests on political grounds when it came to the constructions of major energy projects. Political compulsions of leaders were a source of division over construction of major dams in Pakistan. The political differences between KPK and Sindh put major hurdles in the way of construction of dams.

Globally, states are producing energy through hydel source. China is producing 30,000MW energy from dams and India 4,000MW.[308] Thus, Pakistan is losing billions of rupees per annum because of silence over construction of dams. Under CPEC, energy plants are providing affordable and clean energy but the focus on hydel energy is not up to the mark. It proves that sins of omissions are necessarily destructive.

Various energy policies of Pakistan are well examined in chapter 4. The chapter has explained the prevalent energy policies and practices which are adopted by energy

[306]"Mohmand Dam to be Completed in 6 Years", *The Express Tribune*, (12 February 2018)
[307]Shakil Durrani, "A Tale of Two Dams", *The News*, (22 October 2018)
[308]"CJP Says Kalabagh Dam Inevitable", *Pakistan Today*, (27 June 2018)

governance of Pakistan. The chapter has discussed the idea of institutions and energy governance in Pakistan by explaining; the alignment of energy decision and actions, the development of coordination, and the setting for mutual benefit. The discussion informed the study about the 'Informal Institutions and Energy Governance of Pakistan. The manifestoes of Pakistan People's Party/Muslim League (N)/Pakistan Tahreek e Insaf are found very much aligned to contest for energy provision for quality life in the state of Pakistan. The Formal Institutions and Energy Governance of Pakistan; Pakistan People's Party/Military/Pakistan Muslim League (N) Regimes proved akin to energy decisions and actions. Commissions and Omissions of Energy Governance of Pakistan incubated the energy crisis of Pakistan. Commissions: The committed energy decisions and actions; caused the energy crisis in Pakistan e-g, IPPs Projects. Omissions: The omitted energy decisions and actions; caused the energy crisis in Pakistan e-g, Kalabagh dam. The cases are presented as the maladies of energy governance of Pakistan.

Pakistan China Economic Corridor would be elaborated in the flash of principles of affordable and clean energy in chapter 5. The study would explain that how much the energy governance of Pakistan learnt from the past experience regarding energy security/crisis. And how much it comprehended the future challenges of climate change while having the decision and action regarding CPEC.

# Chapter 5

# China-Pakistan Economic Corridor in Flash of Affordable and Clean Energy

## I. UN Perspectives of Affordable and Clean Energy

Sustainable Development Goal-7

## II. CPEC in Flash of Affordable and Clean Energy

**A.** CPEC Energy Projects

**B.** CPEC Energy Project Evaluation

## III. Energy Crisis Transformation

Ambient Air Quality and Coal Projects of CPEC

## IV. In 2020 Greening the CPEC 2015

# Chapter 5

# China-Pakistan Economic Corridor in Flash of Affordable and Clean Energy

The energy policies and practices which are adopted by energy governance of Pakistan are discussed in chapter 4. The chapter has discussed the idea of institutions and energy governance in Pakistan by explaining; the alignment of energy decision and actions, the development of coordination, and the setting for mutual benefit. The discussion informed the study about the 'Informal Institutions and Energy Governance of Pakistan. The manifestoes of Pakistan People's Party/Muslim League (N)/Pakistan Tahreek e Insaf are found very much aligned to contest for energy provision for quality life in the state of Pakistan. The Formal Institutions and Energy Governance of Pakistan; Pakistan People's Party/Military/Pakistan Muslim League (N) Regimes proved akin to energy decisions and actions. Commissions and Omissions of Energy Governance of Pakistan incubated the energy crisis of Pakistan. Commissions: The committed energy decisions and actions; caused the energy crisis in Pakistan e-g, IPPs Projects. Omissions: The omitted energy decisions and actions; caused the energy crisis in Pakistan e-g, Kalabagh dam. In chapter 5 the facts are marked in view of points deliberated through following question:

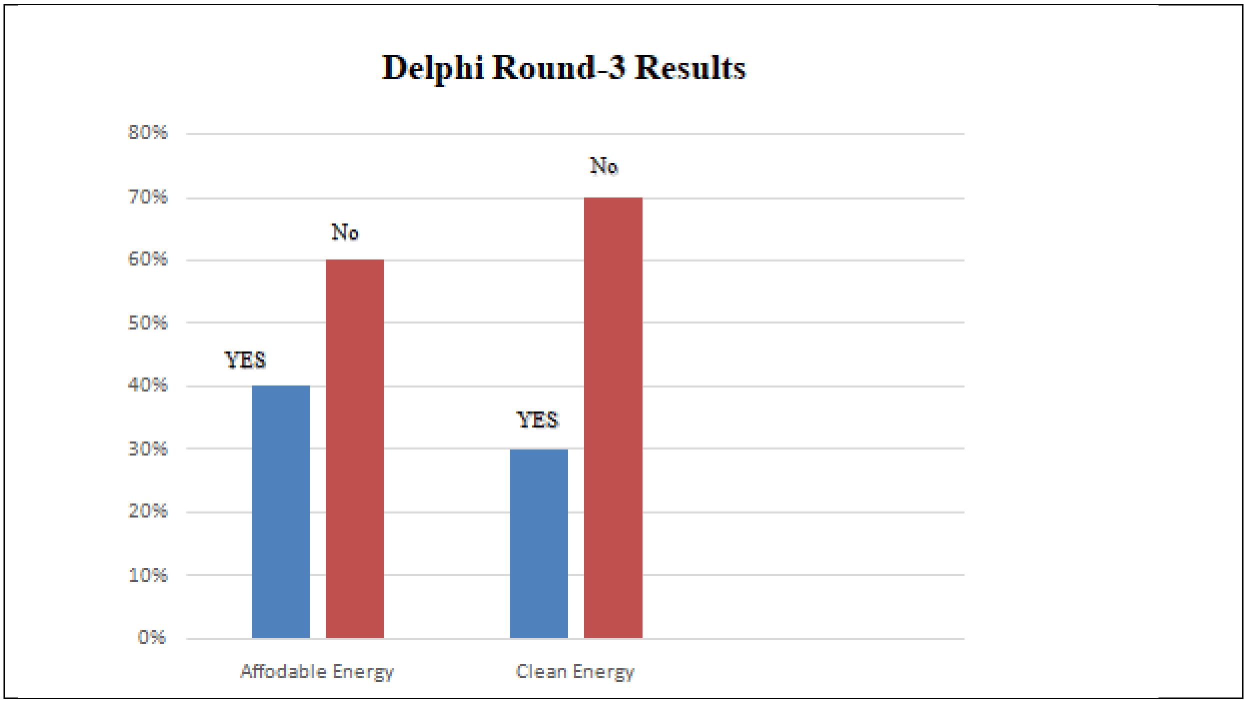
1. How much the energy governance of Pakistan learnt from the past experience regarding energy security/crisis?
2. How much it comprehended the future challenges of climate change while having the decision and action regarding CPEC?

The CPEC 2015 energy decisions and actions in Pakistan are clear evidence of energy production dependency of Pakistan. Institutional and technological interactions define transaction costs[309] that are summed up to proclaim production cost. Chapter 5 assesses the CPEC projects following the energy security index. The study highlights the two dynamics of energy security endorsed by UNO one is affordable energy and the other is clean energy. The energy sustainability is explained in perspective of China Pakistan Economic Corridor (CPEC) signed in 2015. The Delphi round 3 results are presented on the basis of responded

[309]Transaction Cost: In this study Transaction Cost and its Effectiveness is Measured as per the Energy Security Index

knowledge and expertise of 15 experts for this study (See Figure 5.1). The experts (60%) opined that the energy production secured through CPEC will not be affordable; while 70% experts asserted that the CPEC energy will not be environment friendly.

**Figure 5.1: China-Pakistan Economic Corridor in Flash of Affordable and Clean Energy**




**Source**: Self Extract

## I. UN Perspectives of Affordable and Clean Energy

**'The chief of the United Nations has warned Asia to quit its "addiction" to coal in a bid to tackle climate change. UN Secretary General António Guterres said countries in the region were among the most vulnerable to global warming and should be on the "front line" of efforts to stop it. He cited a new study that found that Asian countries were at particular risk of climate-driven flooding. Coal is a major source of power in many Asian countries.'**[310]

[310]"Climate Change: Asia Coal Addiction Must End, UN Chief Warns", Available At: https://www.bbc.com/news/world-asia-50276983 Access On: 27-10-2018

United Nations declared 2014-2024 decade, the decade of sustainable energy. Its purpose was to launch a global initiative to provide affordable and clean energy services by 2030. To achieve this goal, UN prioritized sustainable energy access to its member states. United Nations, through Inter-Agency and Expert Group on SDGs indicators, has developed global indicator framework. SDG-7 has five targets and six indicators. Goals are specified in the targets while indicators signify the metrics through which the world aims to track the achievement of these targets. Table 5.1 shows targets and indicators of Goal-7. The study deliberates target 7.1 and its indicator regarding CPEC energy specifics.

**Table 5.1 Targets and Indicators of SDG-7**

| Sr. No | Targets | Sr. No | Indicators |
|---|---|---|---|
| 7.1 | First target focus on to ensure access to universal energy through affordable and clean energy means by 2030. | 7.1.1 | Ratio of population with energy access. |
| | | 7.1.2 | Ratio of population with fundamental reliance on technology and clean fuels. |
| 7.2 | The focus of the second goal is on the substantive increase of renewable energy share in international energy mix by 2030. | 7.2.1 | The share of renewable energy in the total final consumption of energy. |
| 7.3 | By target third goal, double the global rate of improvement in energy efficiency by 2030. | 7.3.1 | The intensity of energy is measured on the basis of primary energy and GDP. |
| 7.A | By 2030, increase global cooperation to facilitate access regarding research on affordable and clean energy. It includes renewable energy, efficiency of energy and advanced technology of cleaner-fossil fuel. Moreover, to promote investment in affordable and clean energy with improvement in energy infrastructure. | 7.A.1 | Mobilized amount of US dollar per annum starting in 2020 accountable towards the $ 100 billion commitment. |
| 7.B | By 2030, upgrade technology and enhance infrastructure for delivering affordable and clean services of energy in developing countries for all. Particularly, less developed states, land-locked developing states and small island developing states, in accordance with respective program support. | 7.B.1 | For sustainable development services, investments in energy efficiency as a GDP percentage and amount of FDI in financial transfer for technology and infrastructure. |

**Source**: Sustainable Development Goal 7, United Nations, Sustainable Development Knowledge Platform, Available at: https://sustainabledevelopment.un.org/sdg7 Access on 1-7-2019

In United Nations Environment Program, it is believed that sustainable supply of energy provides certain ways to transfigure and glorify the lives of the citizens and the economies of states, safeguarding the ecosystem of the planet. That is why, through SDG-13, United Nations is working with the states to improve efficiency of energy and to promote the increased use of energy produced by the use of renewable energy sources. Through this goal, UN is focusing on four areas of energy.

1. Improve the understanding of science, promoting the link between environment and energy.
2. Provide an advice to governments on sound environment policy.
3. For clean energy, catalyze private and public finances.
4. Support uptake of technologies, related to clean energy.

Different partners of UN are jointly working to improve the efficiency of energy in buildings, urbanization, transport and appliance-manufacture. They are working to strengthen the business case for efficiency of energy, in emerging economies and developing states, which also includes the efforts made on city level. The work of UN contributes SDG-7 (Energy) and 13 (Climate Action) implementation and supports major process of UN like UN Framework Convention on Climate Change (UNFCCC). It also includes sustainable energy for all initiatives. UN Environment in partnership with the Copenhagen Centre on Energy Efficiency, Government of Denmark and the Danish Technical University established the hub of energy efficiency and sustainable energy for all. This Centre also functions as the secretariat of the Global Energy Efficiency Accelerator Platform.[311]

**Interaction between Affordable and Clean Energy in SDGs**

Affordable and clean energy and climate change are the profiles of the same picture which enhance each other and work as the counterparts. In 2015, United Nations Climate Change Conference based in Paris adopted a transformative, universal agreement on climate change. This prominent contract enunciated economic as well as social openings providing

[311]"Ensuring Access to Affordable, Reliable, Sustainable and Modern Energy for All", *United Nations Environment Program*, Issue Brief SDG-7, pp. 1-2

low-emission, ensuring a future of climate resilience. It also focused on the intrinsic relationship among poverty eradication, sustainable development and climate-change actions. Simultaneously, SDGs require actions from all the states to improve living standard of local people throughout the world. In this context, especially SGD-7, in which the energy remained under the focus of international efforts to bring a paradigm shift towards ultimate sustainable development, eradication of poverty, low carbon energy systems and green economies. The Paris Agreement on climate change and the Agenda of 2030, for Sustainable Development. Both the 2030 agenda and the Paris Agreement provide clear path and directions towards clean energy developments.[312]

By 2030, energy will not only be the world goal but it is the entity which lies at the heart of UN Sustainable development agenda as well. Energy is essential for the improvement of health, reduction of poverty and the way to ensure the sustainability of environment. Energy access makes communities safer in all perspectives. In today's modern world, billions of people have no access of energy.

SDG-7 bears a deep relation to SDG-13. As energy or usage of energy has a direct effect on climate, therefore energy and climate change both are global issues and they impact all countries and sectors. For decades, the relationship between energy and climate change remained ambiguous. The UN defined SDGs are and will be impossible to achieve without a greater access to environment friendly energy. In undeveloped or underdeveloped countries or in the areas with poor access to energy, the use of traditional ways- like woods or polluted oil- for cooking cause $CO_2$ emission which badly harms the environment. Access to universal energy is essential for sustainable development and addressing climate disruption challenges. Speeding up the access to universal energy will foster resilience of climate. It is the capability to withstand climate related disruption. Strategies related to access of energy and climate reliance need to go hand in hand.[313]

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[312] "Accelerating SGD 7 Achievements", Policy Brief, UN High Level Political Forum 2018, *United nations Department of Economic and Social Affairs*, p. 119

[313] "Universal Energy Access: An Enterprise System Approach", *Miller Centre for Social Entrepreneurship*, (September 2015), p. 6

# II. CPEC in Flash of Affordable and Clean Energy

Optimized energy structure of Pakistan will ensure certainty of clean energy supply. CPEC has twenty-one energy projects to meet rising energy demands. In CPEC energy, share of coal-based projects is the highest. In 7 coal-based projects 3 projects are Thar coal based and 4 are based on imported coal. However, hydropower comes on the second in the total energy mix. Three hydel power projects are installed on different rivers, as per technical feasibility. The share of solar energy is higher than wind. There is 1 solar project and 8 wind-based projects. Though the share of renewable energy is not up to mark, yet it is a bright spot for Pakistan (See Table 5. 2).

**Table 5. 2 CPEC Energy Mix**

| Sr. No | Source | Share in Total |
|---|---|---|
| 1 | Coal | 69% |
| 2 | Hydro-Power | 21% |
| 3 | Solar | 7% |
| 4 | Wind | 3% |

**Source:** China-Pakistan Economic Corridor 2017, http://cpec.gov.pk/

## A. CPEC Energy Projects

In 2004, Government estimated that half capacity of coal reserves could provide 100,000MW energy, sufficient for 30 years. Pakistan has 185 billion ton of coal reserves.[314] Shortly, about 69% of energy will be obtained through coal.[315] Success of these plants will provide about 880MW. CPEC will increase the usage of indigenous coal from 4.5 to 60 million tons annually.[316] Local coal will replace imported furnace oil and save foreign exchange. In CPEC, three out of seven are Thar coal-based energy production plants. In local coal plants, subcritical technology while in imported coal plants, the more efficient, supercritical technology is being utilized. Capital cost of supercritical technology is higher than subcritical. The discussion over the nature and current status of these projects goes as under:

[314] Zoonia Naseeb, "China-Pakistan Economic Corridor: An Opportunity to Development of Energy Sector of Pakistan", *ICRANET*, (November 2018), p. 204

[315] Arif Rafiq, "The China-Pakistan Economic Corridor: Three Years Latter", *Center for Strategic and International Studies*, (12 February 2018)

[316] "Pakistan 2025: One Nation One Vision" *Ministry of Planning Development and Reform*, (2014), p. 61

**Indigenous Coal Based Projects:** Indigenous coal-based projects use standardized equipment. In these projects, sub-critical and desulfurization technology is utilized. These technologies maximize the efficiency of utilized coal and minimize the emission to keep the environment unharmed.[317]

Engro-Thar-II Lignite Mining Thal Nova Coal Power Project: Engro-Thar-II is lignite mining and local coal-based project. This project is located in Sind, district Tharparkar with 9,000 square Km covered area. It is world's seventh and Asia's biggest lignite mine with 175-billion-ton coal reserves. This project includes coal energy plant and open-pit coal mine. The capacity of open-pit coal mine phase one is to achieve 3.8 million ton per annum. In phase two it will be expanded to 7.6 million ton. It is an investment of $850 million and its construction period comprises of 41 months. Engro Power Gen Thar Ltd is sponsoring it while China Machinery Engineering Corporation (CMEC) is its executing company. However, it is a joint venture of Sindh Government with a share of 52.1%, followed by Thal Limited 12.8%, Engro Power Gen Ltd 12.8%, Habib Bank Ltd 9.5%, Hub Power Company 8.5% and CMEC 4.3% share. In execution of this project, CMEC has a joint venture with partners of Pakistan. Its execution is an investment of $1.2 billion with a period of 42 months. It is developed by Engro Power Gen Thar Pvt Ltd which is a joint venture of Engro Power Gen Ltd with a share of 50.1% followed by HBL 9.5%, CMEC 35% and Liberty Mills Ltd 5.4% share.[318] First unit of Engro Thar Ltd (330*2) started functioning on 18 March 2019 with 330MW generation capacity. According to CEO, Engro Power Gen Thar Ltd, Zafar Syed second phase was supposed to be connected to grid in April 2019. It is fully using indigenous coal and will utilize 3.8-million-ton coal per annum. By June 2019, both projects will achieve commercial operation date (COD). It is expected that after COD, for transmission of 660MW from plant to Matiari, 282-km long 500KV double circuit quad-bundle transmission line will be used.[319]

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[317]"CPEC Energy Projects: China Highlights Four Points", *The News*, (5 March 2018)

[318]Thar Block II Lignite Mining and Coal Fire Power Plant Project, Special Report on CPEC Projects (Energy: Part 9), Embassy of the People's Republic of China in the Islamic Republic of Pakistan, (10 October 2018), Available athttps://pk.chineseembassy.org/eng/zbgx/CPEC/t1627106.htm Access on 18-11-2019

[319]"Thar Coal Plant beings Pumping Power into National Grid", *Dawn*, (19 March 2019)

SSRL Thar Coal Block-I &SEC Mine Mouth Power Plant (2×660MW) (Shinghai): Under Thar Coal and Energy Board, coal-fired SEC Power Plant is executed by Shanghai Electric Power Company. Coal mining is executed by Sino-Sindh Resources.[320] Since 2017, construction of this power plant is in progress. It is located in Sindh and will utilize 6.8-million-ton coal per annum block-1 SSRL Thar coal. At block-1, mining operation is in progress. It is expected that by the mid of 2019, it will start its operation on commercial scale. This power plant has two 660MW units.[321]

Thar Mine Mouth Oracle Power Plant (1320MW) & Surface Mine: The projects of Thar Mine Mouth Oracle Power Plant and Surface Mine are based on Thar coal. It is located in Sindh and will produce 1320MW. Its cost cannot be determined, for its progress is in its initial stage.[322]

Imported Coal Based Projects: For imported coal, super-critical technology is utilized. Major portion CPEC coal-based energy is based upon imported coal. There are four imported coal-based projects in CPEC. Following section will provide comprehensive discussion over imported coal project.

Port-Qasim Coal fired Power Plants: Port Qasim coal power plant is pilot project of CPEC. It is a milestone of China-Pakistan energy cooperation. The capacity of this project is 1320MW (660MW*2). Port Qasim Electric Power Company (Private) Ltd was its executing and sponsoring company which completed the project with about $2 billion. In November 2017, one unit started working while second unit was connected to grid in January 2018. Debt facility of this project was provided by China EXIM bank. Sino Hydro Resources (SHR) holds 51% shares while Al Mirqab Group (AMG) holds 49%.[323]

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[320]"SSRL Thar Coal Block-16.8 Mtpa & SEC Mine Mouth Power Plant", Available At: http://cpec.gov.pk/project-details/9 Access on: 25-03-2019

[321]Digvijay Bhusan, "Biggest Power Plants under China's Belt and Road Initiative (BRI), (23 April 2019), Available at: https://www.power-technology.com/features/biggest-power-plants-chinas-belt-road-initiative/Access On 25-4-2019

[322]"Thar Mine Mouth Oracle Power Plant (1320MW) & Surface Mine", Available At: http://cpec.gov.pk/project-details/25 Access On 25-4-2019

[323]"Port Qasim Coal-Fired Power Plant", Available At: https://www.power-technology.com/projects/port-qasim-coal-fired-power-plant-karachi/ Access on 25-10-2018

Sahiwal Coal Fired Power Plant: Sahiwal Coal Fired power plant is flagship project of CPEC. It is underHuaneng Shandong Rui Group of China. The location of project is Sahiwal, close to 500KV national transmission line. It is efficiently providing generated energy to system, maintaining voltages and reducing T&D loss. It is first supercritical-technology-based coal project of Pakistan. Its construction started on 31 July 2015 and it started functioning in May/June 2017. Its units were completed within the record period of 22 months. This plant is using 10,000 tons coal per annum. It is using Malaysian and South African coal, transported from Karachi, through railway, to plant. The cost of this project was about $2 billion. Out of which, $1.44 billion is commercial loan and $360 million is equity of China. In tariff comparison, the cost of Sahiwal energy unit is Rs 11.40.[324] This plant is generating 9 billion kw/h of energy, meeting the demand of 10M consumers, covering 25% supply gap.

Gwadar Imported Coal Based Power Project: Gwadar coal plant is an early harvest and flagship project of CPEC. Production capacity of this project is 300MW. China Communications Construction Company Ltd (CCCC) is its responsible construction company. Despite its early harvest status, this project is facing certain hurdles like issuance of NOCs, Letter of Interest (LOI) by PPIB, site finalization, tariff determination by NEPRA and some certain objections on the part of government of Balochistan.[325] Gwadar coal plant has two units of 150MW. It has two generators, two steam turbines and two high pressure boilers. Coal for this project will be imported from South Africa or other sources through Gwadar. The estimated cost of the project is $542.36 million.[326]

China Power Hub Generation Company (CPHGC) Coal Fired Power Plant: CPHGC is located at Hub, Balochistan. It is a joint venture of Hub Power Company Ltd (HUBCO) and China Power International Holding Ltd., with equity proportion of 26% and 74%. The cost of this project is about $2 billion. It is financed by Consortium of Chinese Bank with 75%:25%

[324]Parvez Jabri, “Sahiwal Coal Power Plant Fully Meets World Standards”, *Business Recorder*, (14 September 2018)

[325]Fawad Yousafzai, “Delayed 300MW Power Plant at Gwadar to Enter Implementation Stage Soon”, (14 June 2018), “Chinese Firm Gates LoI for Gwadar Coal Power Project”, *Dawn*, (31 May 2017), Muhammad Idrees, “Blossoming Gwadar to have 300MW Coal Based Power Plant”, *Daily Pakistan*, (15 March 2018)

[326]“Gwadar Project: NEPRA Sets Tariff for 300MW Coal Power Plant”, *Express Tribune*, (21 December 2018)

debt equity ratio.[327] On 28 December 2018, one unit of project (660*2) was successfully synchronised with grid system. Within all technical parameters, synchronization of first unit of project was achieved before scheduled time. Unit-2 of the project is in process of synchronization and will achieve COD by August 2019. In post CPHGC scenario, the project will be able to add 9 billion KWh of energy in national grid. It will fulfil energy needs of 4 million consumers. It will consume 3.8-million-ton coal per annum. This project will award reliability and sustainability to energy system.[328] Port Qasim energy plant is superior and is equivalent to 10% of present total energy generation of Pakistan.

Rahimyar Khan Coal Power Plant: Primary energy input of Rahimyar Khan Coal power plant is imported coal. The installed capacity of project is 1320MW. Huaneng Shandong Power is executing and sponsoring company of this project. Estimated cost of the project is $1600 million and it is on initial stage with no prescribed date of its completion.[329]Quaid Azam thermal power company will provide imported coal for this project. This company is headed by ex. CM Punjab Shahbaz Sharif. Present government is not interested in its completion with the stance that surplus energy is already in line. In 8th JCC meeting, held on 20th December 2018, Makhdoom Khusro Bakhtyar proposed its removal from the list to provide structure optimization space for subsequent power market of Pakistan.[330]

**Environmental Sustainability and Coal Based Energy Projects:** CPEC energy projects are tool of boosting the economy of Pakistan and are in line with global consensus on Climate change. For energy sector, it is an environmentally friendly package for absolute development. This massive investment of energy projects shows concerns regarding climatic change and sustainability of environment. It is also argued that these projects will expose new problems and will become the cause of GHG emissions and global warming. It is also argued

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[327]"China Power Hub Generation 2×660MW Coal-fired Power Project", Special Report on CPEC Projects (Energy: Part 8), Embassy of the People's Republic of China in the Islamic Republic of Pakistan, (10 October 2018), Available athttps://pk.chineseembassy.org/eng/zbgx/CPEC/t1627106.htmAccess On 13-11-2018

[328]Arshad Hussain, "Ground Breaking of 1320MW Coal-Fired Power Plant in Hub", *Pakistan Today*, (20 March 2017), CPHGC's Unit 1 Supplies 660MW to Grid on Trial Basis, *The News*, (01 January 2019)

[329]"Rahimyar Khan Imported Fuel Power Plant", Available At: http://cpec.gov.pk/project-details/7 Access On 13-11-2018

[330]Khaleeq Kiani, "Govt Puts Major CPEC Power Projects on Hold", *Dawn*, (14 January 2019)

that Environment Impact Assessment (EIA) aspect is also ignored which will significantly affect the melting of glaciers and harm eco-system. However, in reality, concerned authorities of environment related departments are adopting best means to reduce environmental damages.

Despite massive investment on coal-based energy projects, CPEC also focused on renewable energy projects. In long term plans of CPEC, it is mentioned that in future the major area of investment will be renewable energy projects. To avoid harmful impacts of coal, the second major focus of CPEC is hydel. It will increase sustainability and restrain harmful climatic effects. Similarly, in CPEC, renewable energy projects of solar and wind are on forefront. For long-term sustainability, these renewable energy projects will produce not only affordable energy but also avoid effects of GHG emission.[331] In CPEC, share of coal-based energy is higher. For, coal is cheapest and quickest source of energy. CPEC coal energy plants are using most efficient and advanced technologies for environmental protection such as gas desulfurization, optimized furnace combustion organization, electrostatic precipitators, low $NO_x$ burners, waste water treatment plant, wind proof and dust control net etcetera. Imported coal-based projects are utilizing supercritical technology for production of low-cost energy with maximum efficiency. The technology is in compliance with the standards of World Bank for liquid effluents and GHG emissions. This technology ensures minimum impact on environment.[332] Before construction, all these projects got the approval of government for environment impact assessment.[333]In long-term projects of CPEC, it is stated that China will skill Pakistan in renewable energy technology. China and Pakistan are not only cooperating in making CPEC environment friendly project but also cooperating on trade mechanism of greenhouse. It will offset the cost of carbon emission in environment. To make CPEC, environment friendly project, Pakistan is fully committed with all its promises and objectives of Paris agreement.

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[331]Quraat Hashmi, "CPEC Projects: Is CPEC an Environment Friendly Project", *The EurAsian Times*, (28 March 2018)

[332]Ahmed Malik, "Coal-Fired Power Plant: All Set to Achieve Financial Close by June", *Business Recorder*, (7 March 2017)

[333]"Work at 1,630MW Projects Under CPEC Afoot", *The Nation*, (4 February 2019)

**Sahiwal Coal Power Plant a Test Case of Clean Energy:** Sahiwal coal power plant is first energy production plant of Pakistan which is using supercritical technology. In comparison with old subcritical technology, itis more efficient for this technology lowers the emission of greenhouse gas. This plant is functioning with effective and developed emission control technology. Plant fully follows guidelines of World Bank and Punjab Environmental Quality Standards for coal power plants and it ensures that emission of GHG is well below the environmental limits. It uses technologies of fuel gas treatment which includes Lime-Gypsum Fuel Gas Desulfurization, Low NOx Burners, Flue Gas treatment technologies and highly efficient electrostatic precipitators. These technologies meet both national and international standards of emission. The plant also has the Ambient Air quality Station system of emission monitoring which continuously functions and monitors. These steps ensure that the power plant functions, meeting all environmental guidelines. These facts and figure are not only documented rather they are practical and on 14th of September 2018, during the visit of plant by media, they were presented practically and were appreciated.[334] Focus on building coal energy plants lies in fact that furnace oil required to run the energy producing plants is expensive which gives high price energy for energy mix. Therefore, coal-based plants are being setup to reduce the cost of energy production for energy mix. Government is insistent that coal-based plants are fitted within the frame of latest technology which has reduced emission of pollutants and causes negligible climatic change.

## CPEC Hydro-Power Projects

In CPEC energy projects, Ministry of Water and Power is focusing on the construction of hydro power projects as well. PPIB and Public Private Partnership is supporting the Ministry.

Suki Kinari Hydropower Project: Kunhar River is the main source of Suki Kinari power station. It is located in Manshera District, KPK. This power project is a foreign investment of Suki Kinari Hydro (Pvt) Ltd. The installed capacity of the project is 873.508MW. Suki Kinari is a joint venture of White Crystal Ltd 58%, China Gezhouba Group

[334]"Sahiwal Power Plant: World's Most Reliable and Eco-Friendly Facility", *Daily Times,* (27 September 2018)

Company 20%, Eden Inc Behad 20% and etcetera. It is an investment of $1.96 billion with 6 years completion period. This project includes power house, dam, headrace tunnel, spillways, surge branch, tailrace tunnel and pressing piping.[335] According to Spokesman of KPK Energy Development Organization, work on the project, on full swing, is in advance stage. The unit will start its function by 2022.[336]

Karot Hydropower Project (KHPP): Karot Hydropower Project (KHPP), is one of early harvest projects of CPEC. Its site is Jhelum River, a tributary of Indus River. It is the first hydropower station, based on Chinese techniques and standards. When it will start functioning, it will provide 3.2 billion Kw/h clean energy.[337]The installed capacity of this project is 720MW with an estimated cost of $1698 billion.[338] This is the project of Karot Power Company. This project is joint venture of China Three Gorges South Asia investment Ltd with 93% and Silk Road Venture Investment Company with 7%. In 2016, power purchasing agreement, water usage agreement and implementation agreement were concluded. In January 2016, ground breaking ceremony was held with the aim to speed up the construction to resolve energy crisis. Its formal construction started on December 1st 2016. In March 2017, the project achieved its financial close. It will start functioning by the end of 2021.[339]

Kohala Hydropower Project: Kohala hydropower project is another significant milestone in the management of energy crisis. Its construction is under Kohala Hydropower Company Ltd. It is a subsidiary of China Three Gorges Corporation (CTGC). Its site is Jhelum River, near Muzaffarabad. Its financial cost is about $2.5 billion and its capacity is 1100MW.[340] The construction work is delayed due to the protest of local people on Jhelum River diversion. They claim that this diversion will cause environmental problems and sewerage will increase pollution. Hopefully, it will start operating by 2025. Delay is posing a

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[335]"Suki Kinari Hydropower Station", *Embassy of the People's Republic of China in the Islamic Republic of Pakistan*, (1-10-2018)

[336]"Work on Suki Kinari Hydropower Project in Full Swing", *The Nation*, (14 January 2019)

[337]"Karot Hydropower Projects Enters Comprehensive Construction Stage", *The Nation*, (29 October 2018)

[338]"Karot Hydropower Station", Available At: http://cpec.gov.pk/project-details/16 Access On 12-12-2018

[339]"Karot Hydropower Project" Special Report on CPEC Projects ( Energy: Part 10), Available at: http://pk.chineseembassy.org/eng/zbgx/t1627107.htm Access On 12-12-2018

[340]"Kohala Hydel Project", Available At: http://cpec.gov.pk/project-details/23 Access On 12-12-2018

threat to the increase in its cost.[341] One year's extension is allowed by PPIB on its financial close. The board has asked AJK government to resolve project relevant issues on priority basis.[342]

Phandar Hydropower Project: Potential energy project of CPEC is Phandar hydropower station which is located on Ghizer River near Phandar Lake. Its installed capacity is 80MW. Annual energy generation capacity is 374MW. The progress of the project is under the review the experts of both sides.[343]

Gilgit KIU Hydropower Project: Gilgit KIU Hydropower is located in Gilgit Baltistan. Its installed capacity is 100MW. Its progress is also under the review of the experts of both sides. Hydro-Power projects are environmental friendly, cheap and renewable energy source. They are second major source of CPEC energy. By 2023, these projects will be providing 3.7GW to national grid.[344] Successful completion of these clean energy projects will fortify energy sector of Pakistan.

### CPEC Renewable Energy Projects

Renewable energy replenishes with time. In term, renewable energy is sustainable energy which is clean with no carbon emission. In renewable energy, Pakistan made no significant progress. Yet, in CPEC, renewable energy is providing significant share to energy mix of Pakistan. Wind and Solar projects are on forefront to shun greenhouse effect. Renewable energy projects will not only provide environmental friendly and cheap energy but will also provide sustainability to energy sector of Pakistan.

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[341] Munawar Hasan, "Kohala Hydel consumers to Pay Price for Increased Environmental Outflows", *The News*, (16 April 2019)

[342] Fawad Yousafzai, "PPIB Allows One Year Extension in Financial Close Date", The Nation, (20 February 2019)

[343] "Phandar Hydropower Project", Available At: http://www.wapda.gov.pk/index.php/projects/hydro-power/future/phandar, http://cpec.gov.pk/project-details/77Access On 12-12-2018

[344] Harris Azhar and Amna Syed, op.cit., p. 22

CPEC Solar Power Project: In renewable energy, solar technology is a preferent source of energy generation round the globe. Solar plates comprise of certain auxiliary mini grids with photovoltaic cells which convert direct sunlight into energy and provide uninterrupted energy. On state level, solar power is rapidly replacing conventional methods of power generation. In CPEC, solar power is opening new avenues. Quaid-e-Azam Solar Park is world's biggest photovoltaic power plant. It is located in Punjab on 4500 acres of land. It is sponsored by Zonergy. China Development Bank and China EXIM Bank financed it. Loan and equity ratio of this project is 80%:20%. Under CPEC, Quaid-e-Azam Solar Park was the first energy project to provide energy. Since August 2016, (3*100MW) solar parks have been energized. Statistical data shows that they have the capacity to generate 458 million Kw/h per annum. However, energy consumption of the area is 1481 million Kw/h per annum. Currently, through this solar park 30% energy demand of this area is being met.[345] Its full energy production capacity is 1000MW with an estimated cost of $1302 million. On full throttle, this park may even provide surplus energy. Punjab Power Development Board (PPDB) and Alternative Energy Development Board (AEDB) are supervisors and Ministry of Water and Power is coordinator for this project.[346] Success of Quaid-e-Azam Solar Park is a reassurance for energy sector. On individual level, people are switching to solar energy. In certain areas, WAPDA is installing solar powered street lights. Environment friendly nature of solar power plants makes it a better choice for sustainable energy. However, success of larger solar power plant will promote further renewable energy opportunities for power generation. It is best possible option to manage energy requirement efficiently.

Wind Power Projects of CPEC: Wind energy projects of CPEC will help Pakistan in optimizing the structure of energy sector. Under the umbrella of CPEC energy, there are six wind energy generation projects. All these projects are installed in Sindh province. Like other CPEC energy projects, wind-based power projects are also working in IPPs mode. Alternative Energy Development Board (AEDB) is supervising all these projects and Ministry of Water

[345]"Zonergy Solar Power Project", Special Report on CPEC Projects (Energy: Part 5), *Embassy of the People's Republic of China in the Islamic Republic of Pakistan*, (01 September 2018)

[346]"Quaid-e-Azam 1000MW Solar Park", Available At: http://cpec.gov.pk/project-details/10 Access On 12-12-2018

and Power is acting as coordinating body. In wind-based energy projects, Pakistan has shown significant progress and four projects have started their function.

Jhimpir UEP Wind Farm: It is located in Jhimpir, district Thatta. Jhimpir UEP Wind Farm has started its function by providing 99MW to national grid. It also includes supply of 66 sets of Wind Turbine Generators. Each generator set has 1.5MW generating capacity. It was completed by UEP Wind Power Pvt. Limited (UEPL) the estimated cost of $250 million.[347] This project is foreign investment which also includes a control centre and construction of 132KV substation. On 11 September 2015, commercial contract of project was signed. This project took 16 months for construction. Commencement date of the project was 27 January 2016 and completion were started on 27 May 2017. For project, China Developmental Bank provided $252 million with equity and debt ratio of 25%:75%.[348]

Sachal Wind Farm: Sachal Wind Power plant started its function in April 2017 with generation capacity of 49.5MW. It also includes 33 wind turbine generators with 1.5MW each generation capacity. This project was completed by Sachal Energy Development Pvt. Limited (SEDPL) with the estimated cost of $134 million. Industrial and Commercial Bank of China financed this project with equity and debt ratio of 15%:85%.[349]

Hydro China Dawood Wind Farm: Hydro China Dawood Wind Farm is providing 49.5MW to national grid. It was completed by Hydro China Dawood Power Pvt. Ltd (HDPPL) with an estimated cost of $112.65 million. This is direct FDI. Industrial and Commercial Bank of China and Hydro-China financed this project on equity loan rate of 30%:70%. Annual energy generation capacity of the project is 130GW/h. This generation capacity is sufficient for 100,000 families and an effectively easing energy crisis. It was early harvest and first energy project which was completed under CPEC.[350]

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[347]"UEP Wind Farm", Available At: http://cpec.gov.pk/project-details/12 Access On 12-12-2018

[348]"UEP 100MW Wind Farm Project", Special Report on CPEC Projects (Energy: Part 3), Available at: http://pk.chineseembassy.org/eng/zbgx/CPEC/t1627099.htm Access On 12-12-2018

[349]"CPEC Adds 300MW to National Grid", *The Nation*, (02 January 2019)

[350]"Dawood 50MW Wind Farm Project", Special Report on CPEC Projects (Energy: Part 1), (1-October 2018), Available at http://pk.chineseembassy.org/eng/zbgx/CPEC/t1627097.htm Access On 1-12-2019

Three Gorges Second Wind Power Project and Three Gorges Third Wind Power Project: Three Gorges Second Wind Power Project and Three Gorges Third Wind Power Project both are generating 49.5MW+49.5MW=99MW energy. These projects were completed by Three Gorges Second Wind Farm Pakistan Ltd. (TGSWF) & Three Gorges Third Wind Farm Pakistan Pvt. Ltd. (TGTWF) with an estimated cost of $150M. China Development Bank financed this project. Loan rate of equity of the project is 30%:70%. The project will generate 286.6 GW/h energy annually.[351] CPEC, two wind power-based projects are located in 'CPEC-Energy Activity Promoted Projects'. Cacho Wind Power Project (50MW) and Western Energy (Pvt.) Ltd (50MW) are in initial stage. Table 5.3 shows CPEC energy projects and their energy production capacity.

[351]Latest Progress on the CPEC, "Embassy of the People's Republic of China in the Islamic Republic of Pakistan", (29-12-18), Available At: https://pk.chineseembassy.org/eng/zbgx/t1626097.htm, Access On 1-12-2019, CPEC Energy Projects Updates Available At:http://cpec.gov.pk/progress-update Access On 12-12-2018

**Table-5.3 Energy Production Capacity of CPEC Projects and their Cost in $Billion**

**CPEC Prioritized Energy Projects**
**(Installed Energy Production Capacity 11,110MW)**

| Sr. No | Project Name | Energy Production Capacity (MW) | Cost of the Projects in Billion |
|---|---|---|---|
| **1** | Port Qasim Coal Fired Energy Generation Plant (660MW×2) | 1320 | $2 |
| **2** | Sahiwal Coal Fired Energy Generation Plant (660MW×2) | 1320 | $2 |
| **3** | Engro Thar Block II Coal Fired Energy Generation Plant<br>TEL Lignite Mine Mouth Coal Fired Energy Generation Plant (Thar Block-II)<br>Thal Nova Lignite Mine Mouth Coal Fired Energy Generation Plant (Thar Block-II)<br>Surface Mine Thar Block II Coal Fired Energy Generation Plant | 1320 | $2 |
| **4** | Gwadar Imported Coal Fired Energy Generation Plant | 300 | Yet Not Determined |
| **5** | Shinghai, SSRL Thar Block-I and SEC Mine Mouth Coal Fired Energy Generation Plant | 1320 | $3.2 |
| **6** | Hub Coal Fired Energy Generation Plant | 1320 | $2 |
| **7** | Surface Mine and Thar Oracle Mine Mouth Coal Fired Energy Generation Plant | 1320 | Yet Not Determined |
| **8** | Quaid-e-Azam Solar Park | 1000 | $1.3 |
| **9** | Suki Kinari Hydro-Energy Plant | 870 | $1.7 |
| **10** | Karot Hydro-Energy Plant | 720 | $1.7 |
| **11** | Dawood Wind-Energy Project | 50 | $1.2 |
| **12** | UEP Wind-Energy Project | 100 | $.2.5 |
| **13** | Sachal Wind-Energy Project | 49.5 | $1.3 |
| **14** | Three Gorges Second and Third Wind-Energy Project | 100 | $1.5 |
| **15** | Matiari to Lahore ±660kV HVDC Transmission Line Project<br>Matiari (Port Qasim) —Faisalabad Transmission Line Project | | $3.2 |

**Source**: "CPEC Energy Priority Projects", Available At: http://cpec.gov.pk/energy, Access on 29-03-2019

## B. CPEC Energy Project Evaluation

The China-Pakistan Energy Corridor (CPEC) is one of the fundamental elements of China's Belt and Road Initiative (BRI), a megaproject which aims to revive the centuries-old trade route named the Silk Road. CPEC essentially connects the land-based and sea-based routes of BRI; it is a collection of several energy and infrastructure projects worth $62 billion the foundation of which was laid in 2015 during PML (N)'s government. The purpose of this part of the study is to provide an assessment of the Port Qasim Coal Power Project (1320 MW). It begins with explaining what project evaluation is then moves on to discuss how energy projects are assessed by describing a certain criterion and later applies the criteria to the project under study to reach a logical conclusion. The study samples only one of the CPEC (Port Qasim) energy projects keeping in view that the rest projects have the same characteristics of energy decisions and actions.

"A project is an ephemeral venture with a specific timeline (a beginning and end) which aims to create an exclusive result, service or product".[352] The word temporary applies to the project duration, not the outcome of the project. The latter is expected to last for an indefinite amount of time. Unlike a routine activity, a project is characterized by the presence of a timeline, resources, tools and team; it is also expanding over certain phases from initiation to definition to feasibility study to execution to conclusion.[353] Project evaluation is an objective, credible and systematic assessment whereby data is collected and analyzed to gauge the efficiency, effectiveness and sustainability of a certain project. Project evaluation enables managers to make decisions on how to proceed with a project. Without evaluating a project, one cannot find the lacks and shortcomings in it which can be improved to give one a competitive advantage and ensure its quality for all stakeholders. It is ideal to conduct an objective evaluation with the sole purpose of improvement and betterment not in the spirit of blame and admonishment. Project evaluation criteria vary from case to case but there are certain commonalities found in each of them: status of critical tasks, risk assessment, initial,

[352]"A Guide to the Project Management Body of Knowledge", (Pennsylvania: PMI, 2000), p. 4

[353]"What is Project Management?", *Management Study Guide*, Available On: https://www.managementstudyguide.com/what-is-project-management.htm. Access on 23 November 2019

current and final status, informational relevant to other tasks and limitations to the evaluation.[354]

Project evaluation is of three types; pre-project evaluation is done before the project begins to determine its viability, ongoing evaluation analyses the progress of an in-progress project and post-project evaluation assesses the effectiveness and goal completion of a project that has been finished.[355] The Port Qasim Coal Power Project is complete so this evaluation will be a post-project one.

## Energy Project and its Evaluation

As the name indicates, an energy project aims to bring into existence a framework that produces a certain amount of energy for the population. Energy is the primary driver of all forms of activity in a given society; without it human civilization as we know it may ceased to exist completely. It may be a renewable (derived from sources like wind, water, nuclear, biomass or solar power) or non-renewable (derived from fossil fuels like coal, oil and natural gas).

The world today faces its fair share of political, economic, social, environmental and other issues but all these problems do not occur in vacuum. They are all connected in one fundamental way through energy and its resources. Consequently, if there is a crisis in energy, the ability to do work and maintain a functioning world is in crisis. Pakistan itself has been a victim of severe energy crisis for the past several years characterized by black outs and lack of industrial activity.[356] Evaluating energy projects for their effectiveness and efficiency is not only important in the context of project management as described above but also because if an energy project is not fulfilling the set criteria, it drives the entire society towards wreckage.

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[354]Joseph Heagney, *Fundamentals of Project Management*, (New York: AMACOM, 2016), pp. 140-144

[355]Peter Landau, "How to Improve Your Project Evaluation Process", *Project Manager*, Access On: https://www.projectmanager.com/blog/improving-project-evaluation-process, Access On 30 January 2018,

[356]Pakistan", ADB's Support to Pakistan Energy Sector (2005-2017), *Asian Development Bank*, Available On: https://www.adb.org/sites/default/files/evaluation-document/397216/files/sape-pakistan-energy.pdf. Access On: 30 January 2019

Due to its special nature, energy projects also become difficult to evaluate due to the presence of several variables. In this particular study of the Port Qasim Coal Power Project, The research shall keep the following benchmarks in mind to assess the project.[357]

1. Energy Production Dependency: Know how, as measured by availability (one third weight) and utilization (one third weight) of energy resources as per set of politics (one third weight).
2. Energy Supply Certainty: It measures the level of certainty by which energy supply from a certain project would be available at a certain cost.
3. Energy Affordability: It measures the per capita ability to be afforded of energy produced by a certain project at purchasing power parity (PPP) in USD.
4. Energy Sustainability: It employs environmental impact assessment to gauge the environmental safety and sustainable of a particular project.

Certainty: Transportation risk management has not been evaluated here, because it is difficult to create an appropriate index, given, for example, the wide difference of evaluation factors between sea transport using ships and land transport via pipeline, railway or road.

## Port Qasim Project Evaluation: A CPEC Energy Project

Over the past few decades, Pakistan has been facing a deep energy crisis with a power shortage of around 6000 MW and a demand of around 22,000 MW in the summers. Over the past few years, urban and rural areas were facing load shedding of 12 to 14 hours and 16 to 20 hours respectively.[358] As mentioned earlier, Port Qasim is one of the several energy projects being undertaken by the Chinese government in Pakistan as part of the CPEC under BRI. CPEC was inaugurated in 2015 and is worth $62 billion according to 2017. It has been taken up as a "framework of regional connectivity[359]" by some and a "21st century East India

[357] Musarrat Jabeen, "South Asia and Management of Energy Security", *Regional Studies,* Vol. XXIV, No.3 (2006)

[358] "CPEC's First Coal-Fired Power Plant to Cut Pakistan's Energy Shortfall Significantly", *Pakistan Today,* (3 July 2016)

[359] "Introduction", CPEC, Available At: http://cpec.gov.pk/introduction/1. Access on: 24-11-2019

Company" by others.[360] It is an amalgamation of a variety of projects such as railways, roads, and energy projects that are expected to boost Pakistan's economy, somewhat like the Marshall Plan did to Western European countries in the wake of World War 2.

When it comes to the energy sector of CPEC, there are a total of 15 priority projects, 4 actively promoted projects and 2 potential projects (total 21). Out of the 15 main ones, there are six which each contribute or are expected to contribute 1320 MW to the national grid: Thar Mine Mouth Oracle Power Plant, Hub Baluchistan CPHGC Coal-fired Power Plant, SSRL Thar Coal Block &SEC Mine Mouth Power Plant (Shinghai), Engro Thar Block II, Sahiwal Coal-fired Power Plant, Punjab and, the one under study, Port Qasim Coal Power Plant[361]. The ones in Sahiwal, Port Qasim and Thar are currently operational.[362]

CPEC is supposed to be carried out in four stages: Early Harvest, Short Term, Medium Term and Long-Term projects.[363] The first of these stages is from 2015 to 2019; a large portion of these projects (19 out of 39 with 10 being centered on coal) are in the domain of energy and most have been completed thus far. Port Qasim is one of these projects. This 1320 MW project with a roughly calculated cost of $1.912 billion consists of two 660 MW units, one of which was set in motion in November 2017 and the commission of the second unit was passed in early 2018.[364] It is owned jointly by Sinohydro Resources (a subsidiary of Power China) and Al-Mirqab Group (Qatar) and is located 37 km to the southeast part of Karachi, Pakistan's economic hub.

Port Qasim Project is driven by coal which is burned at high temperatures and the steam generated is used to run turbines which produce electricity. It is a supercritical coal

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[360] Abdur Rehman Shah, "Is the China-Pakistan Economic Corridor a 21st Century East India Company?", *The Diplomat*, (11 November 2016)

[361] "CPEC Projects: Energy", CPEC, Available At: http://cpec.gov.pk/energy Access On 25 November 2019

[362] "Energy Generation: Progress", CPEC Info, Available At: http://www.cpecinfo.com/energy-generation, Access on: 25 November 2019

[363] Ishrat Hussain, "CPEC and Pakistani Economy: An Appraisal", *Centre of Excellence for CPEC*, (2018)

[364] "Port Qasim Coal-Fired Power Plant, Karachi", Power-Technology, Available At: https://www.power-technology.com/projects/port-qasim-coal-fired-power-plant-karachi/ Access on 26 November 2019

power plant[365] which means that that the water running in the plant is supercritical fluid (not in distinct liquid or gas phases). The coal found in Pakistan such as the one in Thar was not of optimal quality considering its composition (it contained large quantities of lime and sulfur) and its unreliable supply. Thus, coal to run this plant is being imported from various countries such as South Africa, Indonesia, Australia and Botswana (almost 4.5 million tons every year). Electricity produced at Port Qasim is transmitted via a 500 kilovolts AC line to the Matiari substation before being transmitted to the national grid.

An evaluation of a project cannot be based on just positive and negative aspects of it; an objective assessment looks at both sides to generate a more holistic view of the topic under study. Therefore, it is appropriate to mention certain positive notions of the project. Port Qasim Coal Power Plant has made tremendous progress when it comes to electricity generation. According to reports, it has provided electricity to almost 4 million families every year and has contributed ten billion units to the national grid.[366] Its power generation capacity is almost ten percent of the current national generation capacity. Moreover, it has also provided approximately 2000 jobs[367] to people of a country with an already high rate of employment.

There are several shortcomings to the project as well. The biggest is certainly the environmental concerns which come with setting up a project that utilizes coal. Coal, also known as "black gold" has historically been the most commonly used source of energy because it is cheap. But its usage all over the world is declining because of its obvious impacts on the environment and its contribution to climate change. In addition to the coal factor, the project exists in a location where it can prove to be disastrous. The mangrove population (a characteristic of Pakistan's southern coast) is at a risk of damage from the plant. Moreover, waste from the plant might affect the water that the local population uses or the water employed by other big industries (e.g., pharmaceutical, edible oil, food and water filtration) in the same areas in the manufacturing of their products thus impacting their

[365] "2×660MW Coal-Fired Power Plants at Port Qasim Karachi", CPEC, Available At: http://cpec.gov.pk/project-details/1. Access on 24 November 2014

[366] "Port Qasim Power Plant Added 10bn Units to National Grid in One Year", *Daily Times*, (10 May 2019)

[367] Mian Abrar, "Port Qasim Coal-fired Power Project: CPEC's First Project Witnesses Emphatic Progress on Ground", *Pakistan Today,* (7 March 2016)

quality. Environmentalists also claim that the project affects public health and marine ecology in the north-western part of the Indus delta.[368]

Despite there being environmental concerns for a coal project at Port Qasim, Sindh's Environmental Protection Agency (SEPA) gave the green signal to the plant and jetty in 2014 and 2015. Officials in the CPEC project claim that procedures such as flue gas desulfurization and seawater desalination are being carried out as environmental protection measures thus making standards for it higher than that of World Bank or EU projects.[369] Some sources have claimed that these approvals by SEPA are ambiguous about ash disposal system or emergency plan in the plant. Karachi's Mayor Wasim Akhtar also oppose the approval granted by SEPA.[370] Coal leakage might even end up in the sea during rainy season, a situation which would become worse in case a tsunami happens. In a country where the effects of climate change are one of the worst in the world, having power plants being run by coal is not a wise policy. The coal plant also adversely affects the ambient noise and air. It has been rightly pointed out, Pakistan is splurging on a coal supply chain with terrible timing, when it is becoming history elsewhere".[371]

In addition to the pollution problem, the prices of electricity have actually gone up despite power generation from the Port Qasim project and others of the same nature being sufficient to tackle the load shedding problem. The reason behind this can be traced to the fact that coal used in the plant is not local; it is imported from other countries (check tariffs on it). Moreover, the Pakistani currency has suffered a hard blow over the past several months. Against the US dollar, the rupee has depreciated by 31% as compared to the 2017 value.[372] Pakistan is also a recipient of an IMF bailout package. Tariffs on electricity have increased by 4.55 rupees since September 2019. Consequently, electricity prices have skyrocketed; circular debt has also stuck the working capital of the project. The use of imported coal by an indebted

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[368]Faiza Ilyas, "Sepa Ignores Environmental Concerns, Approves Coal Power Projects", Dawn, (7 July 2014)

[369]"Port Qasim Power Project", *Belt and Road Initiative,* Available At: https://www.beltroad-initiative.com/port-qasim-power-project/ Access on: 24 November 2019

[370]"Mayor Opposes SEPA Approval for Coal Storage at Port Qasim", *Dawn,* (17 August 2019).

[371]Zofeen T. Ibrahim, "Why is Pakistan Opening up New Coal Power Plants, Even as the World Says Goodbye to Coal?", *Dawn,* (24 June 24, 2019)

[372]"Coal-Fired Power Project's Receivables Swell to $150mln", *The News,* (10 May 2019)

country is essentially “economic suicide”.[373] The maintenance of the project is very expensive tool; the government does not pay based on the power actually produced but rather on the basis of the capacity of the project. All these costs have made electricity unaffordable for the general public.

It is not just CPEC projects which are being run on coal. A report by the World Resources Institute (WRI) has maintained that most BRI projects (of which CPEC is one) in transportation and energy sectors are “carbon-intensive” thus violating commitments made by states in the Paris Climate Change Agreement.[374] However, Pakistan cannot blame China for this crisis driver by expensive, polluting coal because it is ultimately the state representatives who take these decisions (the ruling party cannot reverse or revise these contracts to establish coal power plants).

As mentioned earlier, Pakistan faced a lack of 6000 MW. CPEC’s finished energy projects reportedly contribute around 7000 MW to the national grid. Some might say that this means that Pakistan’s energy crisis is over. This study argues that the energy crisis has merely transformed; energy might be available and jobs have been created now but it pollutes the environment (because it is produced by coal) and it is also expensive (because supercritical imported coal is used). Instead of providing clean and affordable energy to the Pakistani population as the United Nations’ Sustainable Development Goals envisage, costs of electricity have actually gone up and its environmental impacts are disastrous as well.

In short, Port Qasim Coal Power Plant fails the affordability and sustainability criteria of evaluation thus resulting in a transformed crisis in Pakistan. Fifty million Pakistanis are still deprived of energy. As the definition of a project mentioned earlier in this part of the study says, a project is carried out for a specific period of time for a specific purpose. The objective of the Port Qasim project, like others in the energy domain of CPEC, was to alleviate Pakistan’s energy crisis. A transformation in the energy crisis is certainly not its elimination. It was claimed that CPEC energy projects would enable Pakistan to overcome its

[373]Zofeen T. Ibrahim, op.cit.,
[374]Ibid.

energy crisis. The evaluation of the Port Qasim project proves that energy crisis in Pakistan has not been surmounted, rather it has transformed. Pakistan might no longer be dealing with load shedding crises but on the basis of the United Nation's goal to provide "clean and affordable energy", the coal project under study fails. By being based on imported, coal, it is polluting the environment and the prices of electricity have skyrocketed as well.

## IV. Energy Crisis Transformation

It was claimed that CPEC energy projects would enable Pakistan to overcome its energy crisis. The evaluation of the Port Qasim project proves that energy crisis in Pakistan has not been surmounted, rather it has transformed. We might no longer be dealing with load shedding crises but on the basis of the United Nation's goal to provide "clean and affordable energy", the coal project under study fails. By being based on imported, coal, it is polluting the environment and the prices of electricity have skyrocketed as well.

**The impact of energy decisions and actions on future scenario of human habitat the study further steps to highlight the air pollution association with increasing unclean energy development.**

## Ambient Air Quality and Coal Projects of CPEC

Air pollution has become a huge concern in Pakistan these days. Decreasing air quality and increasing conditions of smog in major cities like Lahore and Faisalabad are being caused by a number of reasons and are producing several concerns especially related to health. One of the primary reasons behind it, among others, is the unsustainable energy decisions and actions. Even some energy projects in CPEC are based on fossil fuels (coal) and stand to further worsen the situation. This section of the study begins with an explanation of air pollution with description of Pakistan's current air quality followed by its indicators, causes (with special emphasis on energy sector) and impacts followed by a focus on CPEC coal projects using the unsustainability framework.

**Air Pollution in Pakistan:** The World Health Organization defines air pollution as, "contamination of the indoor or outdoor environment by any chemical, physical or

biological agent that modifies the natural characteristics of the atmosphere".[375] Pakistan is suffering from poor air quality for quite a few years now in addition to other environmental concerns like water scarcity and climate change. The Environmental Performance Index (EPI) ranks Pakistan at 176 out of 180 countries in terms of air quality.[376] Lahore and Karachi lie in the top 5 in world cities with the worst air quality. The following table shows the latest values of air quality in Pakistan (As of December 11, 2019).[377]

**Table: 5.4: Air Quality Level of Various Cities in Pakistan**

| City | Air Quality |
|---|---|
| Karachi | 198 |
| Lahore | 300 |
| Islamabad | 202 |
| Peshawar | 222 |
| Faisalabad | 347 |
| Quetta | 222 |

One manifestation of this air pollution is smog. Lahore, Pakistan's historically vibrant city, becomes victim of smog during winter season. The word "smog" is a derived from a combination of "smoke" and "fog". Fog is the result of a phenomenon called temperature inversion whereby the usual layer of cool air in the earth's troposphere is imbricated by a layer of warm air. Smoke from various areas like the transport and energy sectors, industries and burning of forests comes in contact with an 'inversion cloud' and produced smog. Without this inversion in temperature, smoke would escape further into the earth's atmosphere. The inversion cloud traps the smoke thus causing smog which does not go away until the cloud is dispersed by wind or rain. Because the change in temperature happens primarily as we move into the winter season, smog becomes prominent during that time. It must be stressed that air pollution stays throughout the year.

[375] "Fact Sheet: Air Pollution", *World Health Organization Africa*, Available At: https://www.afro.who.int/health-topics/air-pollution Access on: 10 December 2019

[376] Maryam Shabbir, "Cost of Air Pollution", *Sustainable Development Policy Institute*, (11 June 2019).

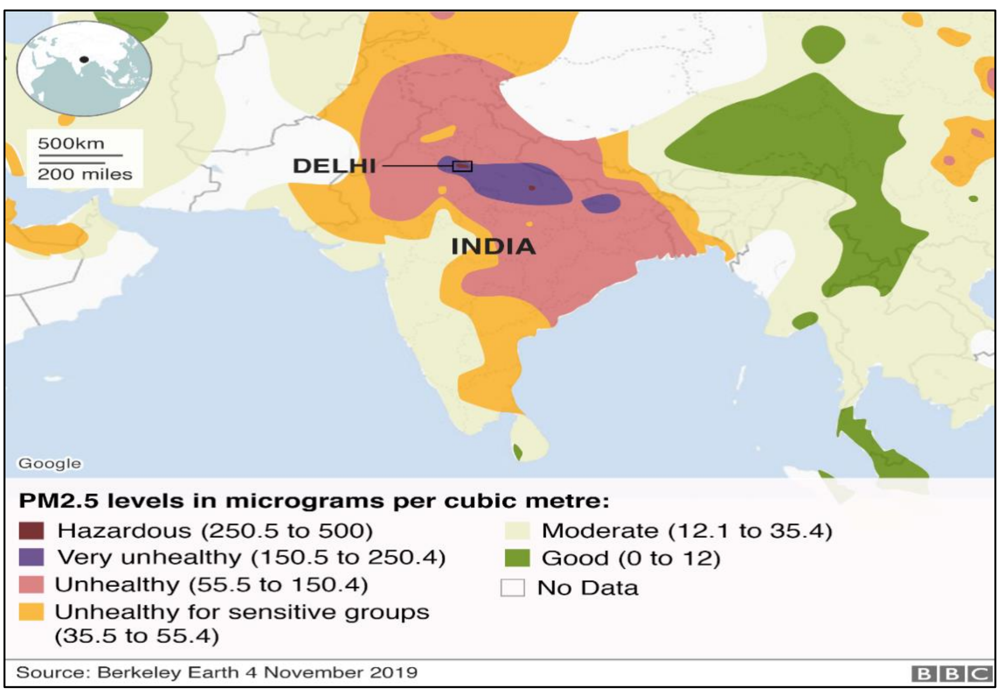
[377] "Air Quality and Pollution City Ranking", Air Visual, Available At: https://www.airvisual.com/world-air-quality-ranking Access on: 10 December 2019

People have started investing in air purifiers, monitors, sealing their windows and doors with rubber stamps and masks when stepping outside. This certainly hasn't improved outdoor air quality but has prevented people from getting sick (at least those who could afford taking care of themselves in smog-ravaged Lahore). These are tiny efforts taken at an individual level which might delay the impending catastrophe but they will certainly not make the situation better thus begging the need for a deeper understanding of the phenomenon.

**National and Regional Phenomenon:** It is wrong to assume that poor quality is only a city-wide problem that affects sight of the people living in the city. Air pollution has grappled not just Pakistan but also parts of India and the wider region and it impacts more than just our ability to see.

New Delhi, India's capital, tops the list of the Air Quality Institute (AQI)'s pollution ranking with a US AQI of 445.[378] The map attached below shows the poor air quality in the South Asian region.[379]

**Figure 5.2: India's Air Quality Level**



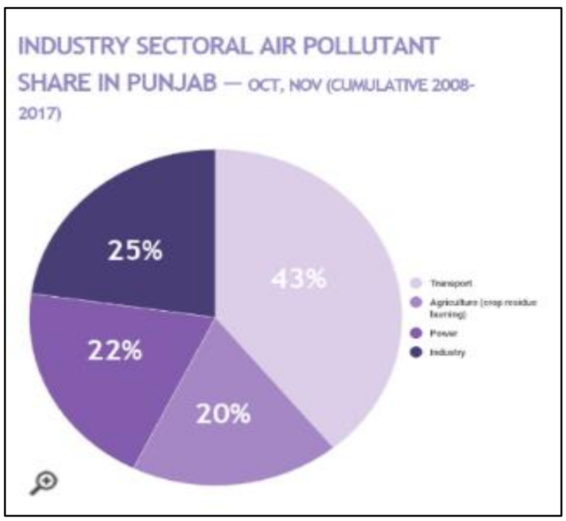

[378]Ibid.

[379]Reality Check Team, "Is India's crop burning polluting Pakistan's Air?", *BBC News,* (8 November 2019)

What all know as “Lahore Smog” is a wider phenomenon which affects the entire Northern region of the subcontinent and smog is just one of its manifestations that happens in the winter season. Most citizens in South Asia breathe toxic air which exists throughout the year; the decreasing temperatures during winter just make it more evident. Why Lahore is primarily associated with this development is because this city was the only one equipped with air quality monitors at the time. Taking the monitors to another city like Muzaffargarh would produce similar results.

**Causes:** In 2018, Agriculture Department of the Punjab Government and UN Food and Agriculture Organization (FAO) carried out a research to investigate the causes of air pollution in Punjab. It was found that transport sector, industries, crop burning (agriculture) and power sectors account for 43%, 25%, 20% and 22% respectively of sectoral emissions in the province.[380]

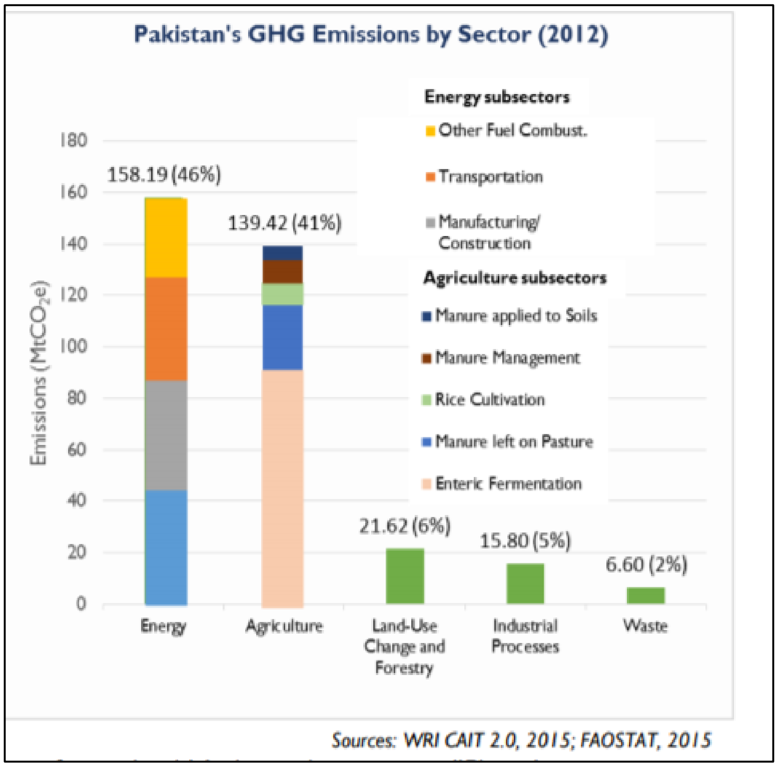
**Figure 5.3: Industry Sectoral Air Pollution Share in Punjab**




Reports by USAID maintain that 87% of greenhouse gas emissions from Pakistan come from the energy and agricultural sectors with the former alone accounting for 46%.

[380] “FAO Report Analyzes the Causes of Smog in Punjab Focusing on Agriculture FAO”, *Dawn*, (5 February 2019)

**Figure 5.4: Pakistan's GHG Emissions by Sectors**




The burning of crops from the Rabi to Kharif season is often taken as the culprit of Lahore's smog. But this assertion fails to acknowledge that crops are also burned in April and May as we move from Kharif to Rabi season but smog does not form because the climatic conditions are not conducive to it. This does not mean that air quality is any better in seasons other than winter. Other than the monsoon season, wind direction in the subcontinent from the west to east. Exceptions exist; on 6th November, 2019, winds were "easterly". The end of October is the season of rice harvest in India. Thus, Indian Punjab and Haryana become home to fires which are blown eastward, causing poor air quality in various cities like Delhi and Dhaka. Mid-November is rice harvest season in Pakistan.[381] Therefore for a month or so, both Pakistan and India burn fires thus further contributing to the smog already prevalent in the region.

[381] Amin Ahmed, "Study Identify Relationship between Smoke and Rice Residue Burning in Punjab", *Dawn*, (7 November 2018)

**Impacts:** According to the World Health Organization (WHO), United Nations' apex body for matters related to global health, outdoor air pollution is a significant source of death and disease throughout the world. This is evident from almost 4.2 untimely deaths[382] that take place every year and a shortened life span brought primarily by respiratory infections (such as bronchitis and emphysema), cell damage in the respiratory system, pulmonary obstruction, stroke and heart disease. For children under the age of 14, the situation is worse. Because they are in a growing age, they have a higher air consumption to body mass ratio. Therefore, air pollution stands to threaten every organ of a child's body (not just the respiratory system). Yale University's 2014 research showed that there are 4.4 million children in Delhi who suffer from irreparable lung damage.[383] In Pakistan, there is a lack of research on air quality and pollution with a few exceptions. A 2019 report of the Energy Policy Institute at the University of the Chicago claimed that deteriorating air quality in Pakistan is reducing the life span of a Pakistani by the average of more than two years.[384] In addition to children, pregnant women and senior citizens are also vulnerable to disastrous effects of air pollution. Research in Belgium showed that even fetuses inside the mother's womb are susceptible to air pollution particles.[385] The health impacts of air pollution cannot be stressed enough. There is no "optimal" level of air pollution and unlike hepatitis or polio for which vaccinations exist, there is no way to develop resistance to air pollution.

**Lack of Government Action:** In 2005, the federal government endorsed the Pakistan Clean Air Programme. It identified vehicular emissions, industrial pollutants, natural dust and combustion of solid waste as the primary sources of air pollution in the country. The programme aimed to curb this menace by improving fuel quality in Pakistan. Considering the severity of the situation, it should have resorted to Euro II, a benchmark which puts a limit on emissions of carbon monoxide, nitrogen oxides and unburnt hydrocarbons. Unfortunately, this standard was not strictly adopted and fuel quality in Pakistan remains very poor. The Lahore

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[382] "More Than 90% of The World's Children Breathe Toxic Air Every Day," *Reuters*, (29 October 2018)

[383] Rebecca Slutsky, "Delhi's Air Pollution and Its Effects on Children's Health", May 14, 2017, Available At: https://yaleglobalhealthreview.com/2017/05/14/delhis-air-pollution-and-its-effects-on-childrens-health/ Access On: 25-10-2019

[384] "New Report: Air Pollution Cuts Pakistanis' Lives Short by More than Two Years", *AQLI News*, (22 February 2019)

[385] Damian Carrington, "Air Pollution Particles Found on Foetal Side of Placentas Study", *The Guardian,* (17 September 2019)

High Court in 2007 and 2018 also recognized the need of curbing emissions while responding to cases of environmental litigation. This shows that the country's public and the government have been aware of air pollution, its disastrous effects and efforts needed to be taken to resolve this issue for several years. Even the courts have suo motu taken up this matter but there seems to be no improvement in the quality.

The biggest problem with the issue of resolving air pollution is its perception within the society and treatment by officials. As mentioned before, air quality remains abysmal throughout the year but it is taken as a serious concern only during smog season in the fall and winter. The so-called elected representatives in Pakistan does not recognize the seriousness of the issue. They often resort to blaming activities in Indian Punjab for the smog created in Pakistani Punjab during the winter season. Such inaccurate statements have been made by the Chief Minister of Punjab[386], the Environment Minister of Punjab[387], the Minister of State for Climate Change and the Minister for Science and Technology. Indian activities certainly are a factor causing air pollution in Pakistan but blaming others is not a solution. Alternatives to crop burning to prepare land for next season do exist such as ploughs but farmers in both countries are too poor to resort to it and governments have not provided opportunities to agricultural workers.

Because this is a mutual issue for Pakistan and India, it is very important for them to cooperate on this issue. In our current globalized world, states cannot afford to resolve concerns without overcoming their differences and come together for the sake of their citizens' well-being. Several South-East Asian countries have formulated the ASEAN Haze Agreement to bring cleaner air for their people with some success.[388] Pakistan also lacks official information on air quality. EPA Punjab has been authorized to monitor quality standards of air in the province but they lack proper equipment and sufficient air monitors thus preventing the availability of a clear picture. Because elected officials have failed to take charge of the situation, citizens have taken action by themselves. Pakistan Air Quality

[386]"Shahbaz Invites Indian Counterpart to 'Join Hands' To Tackle Smog in Punjab", *Dawn*, (21 November 2017)
[387]Intikhab Hanif, "Smog not that Alarming: Govt", *Dawn*, (4 November 2017)
[388]"Conference of the Parties to the ASEAN Agreement on Trans-boundary Haze Pollution", *ASEAN*, Available At: https://asean.org/asean-socio-cultural/cop-to-aathp-conference-of-the-parties-to-the-asean-agreement-on-transboundary-haze-pollution/ Access on 11 December 2019

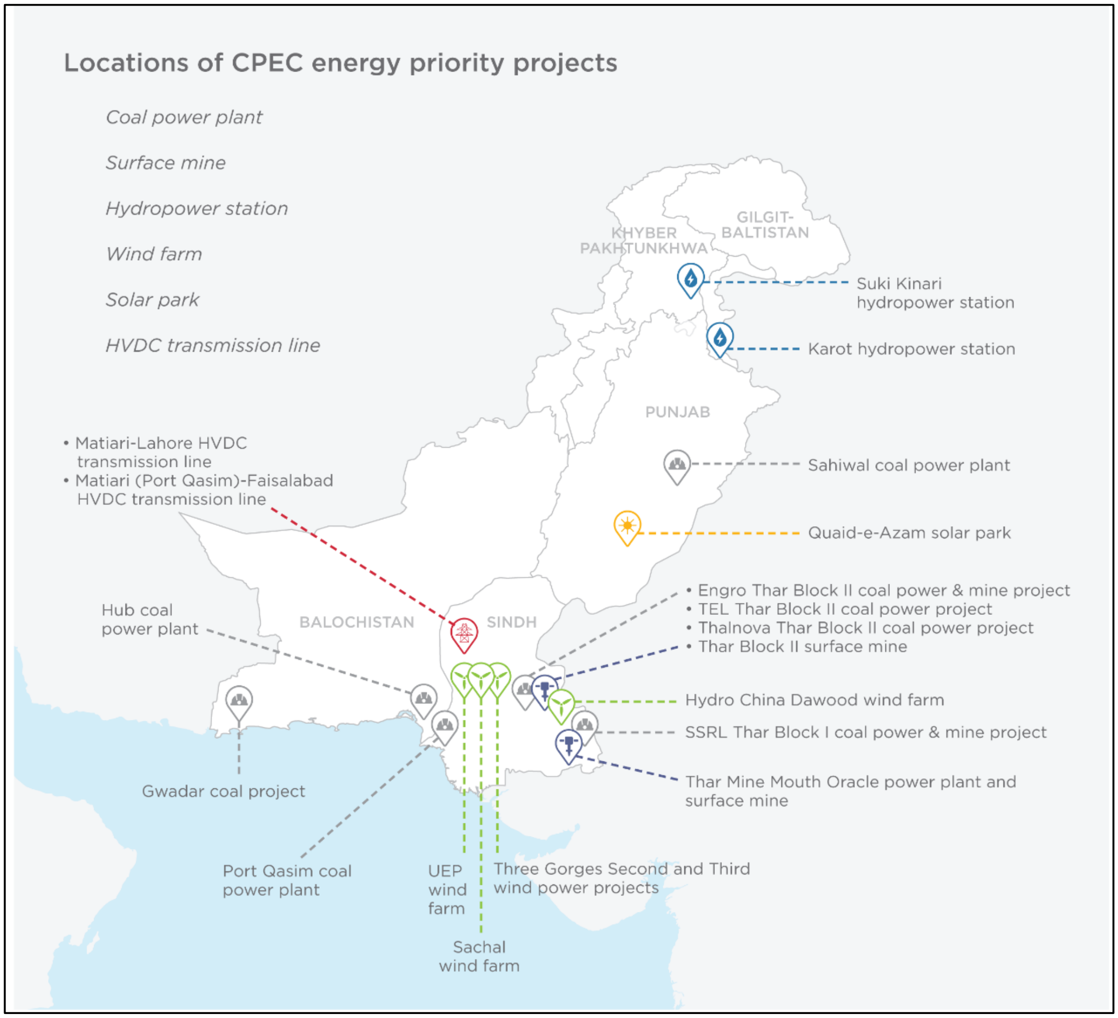
Initiative (PAQI) is a citizen-led enterprise whereby small air quality monitors have been set up in Lahore, Islamabad, Peshawar, Karachi, Faisalabad and Gujranwala. Information about air quality has been shared with the public via the internet but the response of officials at this is not supportive. Instead of taking advantage of these meters, the government has snubbed this information as unreliable. PAQI information is reliable as evident form the fact that the information presented by them was used to shut down schools earlier in 2019[389] during a health emergency situation brought by air pollution.

**CPEC Coal Projects: Studying the Impact on Ambient Air:** In 2018, Greenpeace carried out research to identify concentration of nitrogen dioxide (produced by the burning of substances like coal, diesel, oil and biomass. Lahore fell among the top 50 global hotspots.[390] It is only plausible to claim that this concentration is likely to increase with increased burning of coal in Pakistan with respect to the seven coal-fired plants planned under CPEC out of which two- Sahiwal and Port Qasim plants are currently operational. The following map shows the energy projects undertaken by CPEC.

[389] Panarat Thepgumpanat, "Pollution Prompts Bangkok to Close Schools for the Week", *Reuters*, (30 January 2019)

[390] Laurie Myllyvirta and Emma Howard, "Mapped: Nitrogen Oxide around the World Unearthed", Available At: https://unearthed.greenpeace.org/2018/10/29/nitrogen-dioxide-no2-pollution-world-map/ Access on: 11 December 2019

**Figure 5.5: Location of CPEC Energy Projects**




With an increasing energy demand, it became crucial for steps to be taken to provide electricity access to all citizens in the country. The way adopted by the government of PMLN (2013-2018) was to engage in CPEC with China. If they had played their cards right, it could have been a tremendous opportunity for Pakistanis to achieve the UN SDG of clean and affordable energy. According to research by Columbia University's Centre on Global Energy Policy[391], the government of that time wanted to take credit for the work it planned to do and therefore agreed to coal power plants for short-term power generation instead of investing long term in non-renewables. Conserving foreign exchange was another factor which

[391]Erica Downs, "China-Pakistan Economic Corridor Power Projects: Insights into Environmental and Debt Sustainability", *Centre on Global Energy Policy*, ( 3 October 2019)

apparently compelled Pakistan to take this decision. Consequently, almost 75% of the energy generated by CPEC projects is supposed to come from coal combustion.[392]

As mentioned before, most of Pakistan's greenhouse emissions come from energy sector and within that primarily from coal. The CPEC projects stand to increase Pakistan's reliance on coal by almost 50% in a time when global efforts are being taken to reduce coal reliance. Antonio Guetteres, Secretary General of the United Nations, while in Bangkok for an event commented that coal addiction "must be overcome" to overcome disastrous effects of climate change.[393] Coal-fired plants pose a threat because coal combustion contributes several pollutants and airborne toxins to the atmosphere thus worsening human health and the impacts of climate change. Greenhouse gases like carbon dioxide and methane are produced during the process of combustion and coal formation respectively. Table 5.5 shows the quantity of carbon dioxide that four out of seven CPEC coal projects are estimated to contribute to the atmosphere thus worsening the already poor air quality.[394]

**Table 5.5: Quantity of Carbon Dioxide of four CPEC Coal Projects**

| CPEC Coal Plant | CO2 Emitted per KWh (in grams) | Coal Consumed per KWh (in grams) |
|---|---|---|
| Port Qasim Karachi (Karachi) | 800-880 | 340-380 |
| Sahiwal (Punjab) | 800-880 | 340-380 |
| SSRL Thar (Sindh) | ≥880 | ≥380 |
| China Power Generation Hub (Balochistan) | 800-880 | 340-380 |

**Source**: Moti L. Mittal, Chhemendra Sharma and Richa Singh, "Estimates of Emissions from Coal Fired Thermal Power Plants in India", Radio and Atmospheric Sciences Division, National Physical Laboratory, Council of Scientific and Industrial Research, Available At: https://www3.epa.gov/ttnchie1/conference/ei20/session5/mmittal.pdf, Accessed On: 18-02-2019

[392]Shah Meer Baloch, "CPEC's Environmental Toll", *The Diplomat,* (18 April 2018).

[393]"Coal Addiction Must be Overcome" To Ease Climate Change, *UN News*, (02 November 2019)

[394]Ali Salman Andani, "CPEC: The not so Cool Coal Corridor", Modern Diplomacy, Available At: https://moderndiplomacy.eu/2018/08/14/cpec-the-not-so-cool-coal-corridor/ Access on: 14-08-2018

In addition to pollutants from coal combustion, experts claim that coal-fired power plants have set the smog off in Pakistan. The focus for this section may have been air pollution but the same coal projects also contribute to increase in average temperature and disrupt the water cycle.  In short, the environmental disasters brought by these coal projects far outweigh the perceived economic benefits.

With an increasing energy demand, it became crucial for steps to be taken to provide electricity access to all citizens in the country. The way adopted by the government of PMLN (2013-2018) was to engage in CPEC with China. If they had played their cards right, it could have been a tremendous opportunity for Pakistanis to achieve the UN SDG of clean and affordable energy. According to research by Columbia University's Centre on Global Energy Policy[395], the government of that time wanted to take credit for the work it planned to do and therefore agreed to coal power plants for short-term power generation instead of investing long term in non-renewables. Conserving foreign exchange was another factor which apparently compelled Pakistan to take this decision. Consequently, almost 75% of the energy generated by CPEC projects is supposed to come from coal combustion.[396]

## In 2020 Greening the CPEC 2015

Belt and Road Initiative (BRI) 2013 had prelude the UN endorsement of Sustainable Development Goals (SDGs) in 2015. The two international public goods have shared concepts, objectives and principles. The 17 goals for Sustainable Development seem supported by the principles of BRI named; policy coordination, facilities connectivity, unimpeded trade, financial integration and people-to-people bond. BRI is found styled to construct ecological civilization being proactive to manage the enlarging challenge of climate change to human sustainability.  The international community has positively recognized the role of BRI in defining and operating the emerging economic geography transcending the continents of Asia, Africa and Europe. It will promote global actions to address the common

[395]Erica Downs, "China-Pakistan Economic Corridor Power Projects: Insights into Environmental and Debt Sustainability", *Centre on Global Energy Policy*, 3 October 2019

[396]Shah Meer Baloch, "CPEC's Environmental Toll", *The Diplomat,* Available At: https://thediplomat.com/2018/04/cpecs-environmental-toll/ Access On: 18-04-2018

challenge of environment and poverty by forging reasonable and fair global governance systems. BRI is committed to align with green principles of SDGs emphasizing the low-carbon construction and elevating collaboration to protect the environment, conserve biodiversity and mitigate the climate change impact. BRI will help the connected countries:

- To promote policy communication for implementing SDGs
- To construct governance systems to prevent environmental risks
- To green the financial integration
- To enhance the capacity building to practice the SDGs

China has extended its economic strength by way of initiating the China-Pakistan Economic Corridor (CPEC) in 2015 meaning economic development of Pakistan on confluence of South Asia-West and the Central Asia. CPEC project posits to develop energy corridors to manage the energy crisis of Pakistan to invigorate the economy. Though the energy mix of CPEC 69% is dominated by coal-based power generation; but there can be the opportunities to promote renewable energy by processing solar, wind and hydel energy policies and business intimacy with the Chinese enterprises. Possibility arises to benefit from China's experience and expertise regarding solar technology at economical price to comprehend the future challenges linked to climate change impact on Pakistan. China and Germany are known the top most countries of the world for developing and utilizing solar energy to support their inland energy systems modestly. China's Foreign Direct Investment can be a source to develop solar energy in Pakistan.

The renewable energy domain seems promising to fruition the objectives CPEC the flagship of Belt and Road Initiative 2013. The available cooperation of China can be the source of benefit. The scenarios are in view equipping the low-cost local force with necessary skills to promote the green energy. The universities and the scientists in Pakistan must be linked to Chinese universities and incentivized to research the energy governance of Pakistan. Political economy of energy in China must be utilized in Pakistan to mindset the politicians of Pakistan. Since the ultimate decisions have to come from politicians, they may be given

requisite exposure of the subject through a series of seminars, trainings aimed at ‘Energy governance.’

China’s trajectory of its stakes based on BRI abounds it to curve the potential of international economy. It insinuates its potential to manage the climate change impact as well. China is the top most country of the world to spend on climate change management projects. The fact is manifested in the US policy as well. America invited China in the Climate Summit in April 2021. Bill Gates is proven imminent to appreciate China’s fortitude to prioritize climate change impact and its will to reduce the carbon emissions. He further emphasized that the world community must benefit the China’s efforts for manufacturing the green energy affordable products. The cash-strapped poorer countries can utilize rechargeable batteries and solar power panels made in China. China must be appreciated because of its achievements to build up its energy grid to organize further renewable energy. The transport in Chinese cities is being added with electric buses. The facts determine the ideas of same practices in China-Pakistan Energy Corridor (CPEC) included in the Belt and Road Initiative (BRI).

**The Green Energy Potential of Pakistan:** Pakistan’s contribution in ecological footprints is 0.79%. It is ranked 184 out of 188 countries causing emissions. The "Global Climate Risk Index 2021", has showed Pakistan the 8th most vulnerable country to climate change. Climate change is perceived security threat multiplier in the region of South Asia. Three of the countries particularly India, Pakistan and Bangladesh share the rivers dependent on the depleting Himalayan glacier system. Climate Ambition Summit was convened in Glasgow in December 2020. It was the five-year anniversary of the Paris Agreement. The Prime Minister Imran Khan of Pakistan articulated the desire to compose Pakistan to turn out 60%of energy demand by utilizing renewable resources through 2030. The goal can’t be achieved only by relying on ‘Ten Billion Trees Tsunami Program’ 2019-23. Pakistan has to raise sufficient investment in the resources referred renewable energy namely solar, wind and hydro. The conversion of coal fired plants is also desirable. Effective mechanisms to prevent pollution needs to be developed and implemented.

There are good signs: that few of coal fired projects are shelved, and the development of 'Hydro China Dawood Wind Power Project' close to Karachi has begun. But all the CPEC projects need be vitalized keeping in view the climatic predictions vis-à-vis in and around South Asia. Pakistan could have expected to have US support regarding greening Pakistan. But "The US president Joe Biden had in April 2021 invited 40 world leaders in Summit on Climate, including those from India, China and Bangladesh, to the summit. It was understood at the time that Pakistan had been skipped from the conference despite being one of the most vulnerable countries in the world to climate change."[397] The circumstances advise Pakistan to become more relevant to Chinese largesse. The largesse may be strategized by the decision support systems of Pakistan to count the public and private investments between China and Pakistan. Pakistan has to position a top concern on navigation of newer CPEC projects towards addressing ecological challenges in front of the country. Definitely, both China and Pakistan have a lot further effort to do proviso they actually wish for to go round CPEC into a drawing for greening the ambitious BRI.

The ruling government of Pakistan expressed the ambitious targets in the Glasgow Climate Summit 2020 to boost the contribution of energy generated with alternative and renewable sources to 20% by 2025 and 30% by 2030. The existing share of renewable energy stands at a meager 6 per cent of energy production. But due to the alternating nature of renewables and Pakistan's not-so-well turned-out' transmission and distribution grid, the reaching of these targets foresees the challenges. While opting for renewable energy reflects the need of sufficient investment in Pakistan's energy transmission system. It will make sure to facilitate the reliability of energy consumption systems. The placement of Phasor Measurement Units and Flexible AC Transmission Systems will help this idea into practice. The existing energy distribution systems have to be upgraded to safely embrace the increase in the utility of energy renewable by composing collaboration with China.

[397]Naveed Siddiqui, US Invites Pakistan to Virtual Climate Summit After Earlier Overpass", *DAWN*, (19, April 2021)

The most capable renewable energy projects should be selected via competitive bidding processes. The approach is appreciated as competition for the market. The government can intervene to regulate the bids on merit for longer project life.  In this way investors in renewable energy projects are supposed to become more responsible for market risks. The trend may give relief to government and clients. The entities may benefit from lesser energy prices. Pakistan can establish energy markets by collaboration with the Chinese experts. The energy governance in Pakistan has initiated to organize the processes to indigenize the renewable energy production. For this purpose, the testing labs in Pakistan would be required for renewable energy resources such as solar panels.  These labs resolve need to organize testing at both national and international principles to ensure that only worth apparatus is produced and installed. China can be the source to uplift Pakistan for such development and capacity building. China's Bagasse energy expertise can be the source to develop and enhance the green energy potential of Pakistan. Credit to energy facilitated by distribution companies. Bagasse-powered sugar mills can be able to transfer their excess energy to further industries which will help to manage Pakistan's energy demand.

By streamlining the green energy potential of Pakistan with the China's CPEC/BRI initiatives Pakistan may work to elevate the green energy trends in the state. For this purpose, the development of small hydro projects in the northern areas of Pakistan, the solar projects in the far-flung areas of Balochistan, and appreciation of developing wind energy in the province of Sindh seems rational and practical to green the CPEC 2015. The guiding principles of energy policy of Pakistan include green energy, the utilization of indigenous resources and less cost of production. But the existing commitments of the state referred 1994, 2002 and 2015 foreign funded energy projects drag the government to work for the principles. The projects heavily depended on fossil fuels which are not environment friendly. Encouragement to the use of electric vehicles also the business activities spun as a result of the China Pakistan Economic Corridor (CPEC) are rest to make possible the accumulation of newer and greener sources of energy in the standard economy of Pakistan. 3,500MW of large hydro energy projects are the connected part of CPEC as compared to its 6,900 MW of coal fired projects. While hydro energy is renewable, large hydro energy projects have costs in social and environmental terms. It is possible with due collaboration with China's newly technology

breakthrough in April 2021 to run coal fired energy production with ‘ZERO’ carbon emission.[398] All the same, CPEC deal also covers 1,000MW solar, and 400MW wind energy projects. Irrespective of CPEC, while Pakistan ends up over 11,000MW of fossil fuel run plants till 2047, production of over 22,000MW from 5 sequenced dams on the Indus river together with Diamer-Basha and Dasu power projects, resolve a long term system in the growth of renewable energy generation in Pakistan.

In the second phase of CPEC agriculture has been added in the areas of collaboration between Pakistan and China. The phase II of CPEC has deliberated between the two countries in Dec 2020. The new areas of collaboration include environmental sustainability, climate resilience, green energy, green economic recovery, air pollution, water security and disaster risk management. Pakistan is all the same working on ‘Clean Green Pakistan’ that plans to extend the protected area from 13% to 15% by 2023. The project will help to create five thousand jobs in the state of Pakistan.[399] The government of Pakistan has initiated “Ten Billion Tree Tsunami Program” with the cost of 125.1843 rupees. It is a four years program (2019 to 2023) and is being implement through Ministry of Climate Change. According to the ministry plantation target of 430 million trees has been achieved and till 30 June 2021, the target of 1 billion trees plantation will be achieved.[400]

The study recommends:

1. Proactive participation in the international and regional climate governance systems
2. Promotion of coordination to implement the strategies comprising policies and benchmarks of eco-friendly technologies
3. Encouragement to green investment based on environmental impact assessment
4. Capacity building of formal and informal institutions for sustainable development.

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[398]Sahiwal Coal Power Plant has Achieved Zero Carbon Emission: CHNG”, *Pakistan-China Institute*, 17 April 2017

[399]Noor Aftab, “CPEC to be Turned into Model Green Belt Initiative”, *The NEWS*, 15 December 2020

[400]Ten Billion Trees Tsunami Program-Phase-I Up-Scaling of Green Pakistan Program (Revised), Available At: http://www.mocc.gov.pk/ProjectDetail/M2QzOWJmMjUtZTU3MC00NmFkLWE4YmMtZDFhMmRlOGU2NGRh. Access on 24-04-2021

The concerted efforts of China and partners of BRI particularly of Pakistan the owner of CPEC may fruition the efforts to green the global governance for sustainable development.

Pakistan China Economic Corridor is elaborated in the flash of principles of affordable and clean energy in chapter 5. The study has explained that the energy governance of Pakistan mostly found not learnt from the past experience regarding energy security/crisis. It has not comprehended the future challenges of climate change while having the decision and action regarding CPEC. The chronic energy crisis of Pakistan indicated by load shedding or power outages; have now taken the dimensions of high energy prices and negative effects on natural environment.

# Conclusion
# Conclusion, Findings and Recommendations

## I. Conclusion

### A. Maladies in Energy Governance

1. Malady of Complex Decision-making
2. Malady of Multiple Institutions in Pakistan’s Energy Governance
3. Malady of Pakistan’s Energy Mix
4. Malady of Centralized Energy System
5. Malady of Legal constraints
6. Malady of Circular Debt
7. Malady of Price Determination Mechanism
8. Malady of Fragile Security Situation

### B. Energy Specifics of China-Pakistan Economic Corridor

## II. Findings

Delphi Result Round 1
Delphi Result Round 2
Delphi Result Round 3

## III. The Seven Recommendations

1. Long Term Energy Plans
2. Capacity Building of Energy Governance
3. Research on Energy Development
4. Coordination among Institutions for affordable and clean energy
5. Vitalizing Energy Relations with China and Germany
6. Dependence on Foreign Investment must be reduced
7. Beyond the Election Cycles

# Conclusion

## Conclusion, Findings and Recommendations

This study is specific to Energy Crisis of Pakistan. The trends such as energy outages, high energy prices, unemployment, trade deficit, circular debt, slow economic growth and current account deficit are the indicators of energy crisis. They have affected the economic security of Pakistan. Pakistan faced the energy shortfall of 5,000-7,000MW in view of 26,000MW demand and 19,000MW supply in 2015. Pakistan has resorted to energy production policies particularly associated to foreign investment to fill the energy deficit. China took economic-strategy response to prevalent energy crisis in Pakistan and signed China-Pakistan Economic Corridor (CPEC) project in 2015. (CPEC) a project of $62 billion investment allocated 73% for energy production in Pakistan. The economic uncertainty created by energy crisis pushed the energy governance to ensure energy supply. It welcomed foreign investment offered by China. This research unveils the factors behind these constructs.

The energy crisis referred energy governance of Pakistan is outlined by the application of Institutional Theory. Consisting informal and formal institutions framework deliberated the opportunity set of CPEC the kind of organizations that have come into existence. This research developed a theoretical construct to describe the relationship between the dynamics of energy crisis and energy governance linked with energy projects. The research extends its value of business incentives from intra state level to interstate level. That becomes an addition into the literature of institutional theory. This study presents data by using 'Delphi Analysis' method that includes: causes of energy crisis, energy governance and energy specifics of CPEC to ensure affordable and clean energy as endorsed by the UNO 7$^{th}$ SDG. The study would be useful to enable government of Pakistan to ensure energy crisis management that will improve quality of life of the people of Pakistan; through enhanced socio- economic development opportunities.

## I. Conclusion

The study concludes that the evolved energy crisis occurred because of neglect of earlier experience of energy decisions and actions. The global climate change predictions are also ignored while planning the energy development. The energy decision and action in the 2015 was to generate energy with minimum cost. It focused on the use of coal in the power plants. Meanwhile, China was interested in exporting its excess power generation equipment and mobilizes its economic institutions to provide their assistance in coal-oriented projects.

The study recognizes the significance of energy for human life in past as well as in present, and its historical perspective in terms of security along with its extended spectrum on national security has been provided. The application of Energy Security Index (ESI) through four defined indicators has also been carried out for a better understanding of security situation of Pakistan in chapter 1. It has covered security aspects of dependency including availability and utilization of energy resources; its supply through transmission network; its affordable costs; sustainability as per environment impact assessment; depleting energy resources along with discovery and development of new resources; and reliability in resilience to the natural disasters. The energy crisis has indicated that Pakistan is not doing well in terms of energy security. Considering the past experience and future challenges of climate change, coordinated and efficient energy governance can ensure the governance of energy crisis. An increased dependency upon the alternative and renewable sources of energy particularly solar energy and generally in the form of a distributed energy generation system can address most of the shortcomings in this regard.

The discussions in chapter 2 takes the study to establish that the capacity of institutions empowers the states to plan the economic security based on element of energy. As per the dimension 1 of the energy security index, "Energy Production Dependency: Know how, as measured by availability (one third weight) and utilization (one third weight) of energy resources as per set of politics (one third weight)," applied in the study the state of Pakistan possesses the informal and formal politic-economic institutions with the least capacity to perceive the energy crisis of Pakistan keeping in view the past experience and future challenges. The findings are based on facts of non-alignment of expectations and actions of the

individuals in informal and formal institutions of energy governance, lack of coordination among formal institutions, in-evidence of mutual benefit. The energy available is neither affordable nor clean; irrespective of the $34 billion CPEC project 2015 to diminish the energy crisis of Pakistan.

Chapter 3 found that in Pakistan most of the problems contributing to energy crisis are shaped by the energy governance of Pakistan. Energy governance determined to handle unbalanced energy mix, depletion of fossil fuels, circular debt, decision making delays, gap between installed capacity and actual generation, corruption, mismanagement can become a source of energy security of Pakistan. The demand of energy is increased because of the rising temperature and protracted summers. High population growth with increased socio-economic development and the energy-based luxury prosperity have further supported the energy crisis. Lack of affordable and clean energy has become a threatening issue in economic strategy of Pakistan. It is observed that many small industries have shut down, which are largely the result of inefficiency rooted in centralized energy system due to the dearness of energy.

Chapter 4 has explained the prevalent energy policies and practices which are adopted by energy governance of Pakistan. The chapter has discussed the idea of institutions and energy governance in Pakistan by explaining; the alignment of energy decision and actions, the development of coordination, and the setting for mutual benefit. The discussion informed the study about the 'Informal Institutions and Energy Governance of Pakistan. The manifestoes of Pakistan People's Party/Muslim League (N)/Pakistan Tahreek e Insaf are found very much aligned to contest for energy provision for quality life in the state of Pakistan. The Formal Institutions and Energy Governance of Pakistan; Pakistan People's Party/Military/Pakistan Muslim League (N) Regimes proved akin to energy decisions and actions. Commissions and Omissions of Energy Governance of Pakistan incubated the energy crisis of Pakistan. Commissions: The committed energy decisions and actions; caused the energy crisis in Pakistan e-g, IPPs Projects. Omissions: The omitted energy decisions and actions; caused the energy crisis in Pakistan e-g, Kalabagh dam. The cases are presented as the maladies of energy governance of Pakistan.

With an increasing energy demand, it became crucial for steps to be taken to provide electricity access to all citizens in the country. The way adopted by the government of PMLN (2013-2018) was to engage in CPEC with China. If they had played their cards right, it could have been a tremendous opportunity for Pakistanis to achieve the UN SDG of clean and affordable energy. According to research by Columbia University's Centre on Global Energy Policy, the government of that time wanted to take credit for the work it planned to do and therefore agreed to coal power plants for short-term power generation instead of investing long term in non-renewables. Conserving foreign exchange was another factor which apparently compelled Pakistan to take this decision. Consequently, almost 75% of the energy generated by CPEC projects is supposed to come from coal combustion.

Pakistan China Economic Corridor is elaborated in the flash of principles of affordable and clean energy in chapter 5. The study has explained that the energy governance of Pakistan mostly found not learnt from the past experience regarding energy security/crisis. It has not comprehended the future challenges of climate change while having the decision and action regarding CPEC. The chronic energy crisis of Pakistan indicated by load shedding or power outages; have now taken the dimensions of high energy prices and negative effects on natural environment.

## A. Maladies in Energy Governance

The study has found following maladies in the energy governance of Pakistan.

**Malady of Complex Decision-Making:** Various offices involved in making energy polices is having a very long list which includes distinctive ministries and institutions. Different sectors of energy in the country are being supervised by around 29 different organizations. These organizations include Ministry of Water and Power along with its 19-secondary agency, Ministry of Planning and Development with its energy wing, Ministry of Petroleum and Natural Resources and its 16 secondary agencies, Ministry of Urban Affairs, Foresty and Wildlife and Ministry of Food, Agriculture and Livestock deals with biomass. Till the creation of Ministry of Energy in August 2017 with the unification of Ministry of Petroleum and Natural Resources and power wing of WAPDA, dealing with energy had been

the primary responsibility of Ministry of Water and Power, while Ministry of Petroleum and Natural Resources managed the energy generation from oil, gas and coal. PAEC managed the Nuclear energy of a country. Mineral Development Cooperation works on exploration and survey of coal. Consequently, this complex organizational setup is illustrated in variety of conflict of interests, lack of preparation, composition and application of energy policies.

Although, energy conservation and management ordinance was also planned with the establishment of national energy conservation program, but no considerable outcomes have been achieved so far. This shows the infirmities of the regulatory authority for energy proficiency of the country. The financial management, energy purchase and sales and in the appointment of senior management over the operating companies (GENCOs and DISCOs) has been deleteriously influenced by the centralization of PEPCO. The incompetence of government is also revealed in the approaches of its decision and policy making by reason of which energy supply is restricted. On the contrary, it is essential that private investors are given with some relaxation in the regulatory restrictions for the purpose to attract private investment in a country. Apart from it, NEPRA takes approximately 6 to 10 months to determine tariffs. In addition to it, further delays in the implementation of government decisions, and discouragement of investors caused by the sophisticated bureaucratic procedure and lack of administrative competence. For instance, despite separate determinations made by NEPRA earlier, the government delayed the announcement of separate tariffs for all corporate distribution companies. The entire organizational setup of energy sector is very multifaceted and has adverse implications on energy supply this condition of NEPRA is no exception.

Primarily, in Pakistan, NEPRA was developed as regulatory authority. However, it controls and monitors energy market (energy market is outlined as the trade of energy commodities). Whereas in Pakistan, a single energy market regulator or a single integrated energy regulatory authority is not found which considered as the one who safeguards the interests of all stakeholders in energy market competently. Particularly, in their corresponding roles NEPRA and OGRA also lack autonomy. They generally make confusions among investors and pricing planning between oil and gas departments. There are also signs of poor efficiency showed by the public-sector companies, which are producing less amount of energy

per unit of fuel as compared to private energy plants. While where some of Pakistan's plants require up to 14,000 to 15,000 btu per kWh, the efficient plants use about 8,500 btu to generate one kilowatt-hour (kWh) of energy Although, the government seemed fail in enforcing commercial discipline and accountability on utilities as it is understood by government and NEPRA that these inefficiencies and mismanagement issues need to settle. NEPRA has set targets for all distribution companies, whereas, no procedures were taken when these targets were not met. Eventually, the government ends up paying for these extra damages, with the purpose of clearance of the country's circular debt.

Almost all explanations of energy supply crisis are complicatedly amalgamated. From the above detailed discussion on factors behind insufficient supply we extract that most of the problems are a result of bad governance, ranging from circular debt, tariff determination, decision making, and mismanagement inefficiency. Good governance is a course of making and implementation of decision with efficiency and accountability. However, in the precedence of these key issues, Pakistan suffers from institutional and structural disconnections and mismanagement. Therefore, it is understood that, either by complimentarily approving public investment inappropriately or by imperiling exceptionally important projects for their vested benefits, vast damages have been caused by policy makers.

**Malady of Multiple Institutions in Pakistan's Energy Governance:** In Pakistan, till 1990's, Water and Power Development Authority (WAPDA) and Karachi Electric Supply Company (KESCO) were managing the energy sector. Both departments were responsible for the production, transfer and distribution of electricity. Till 1990's, the performance of both sectors was satisfactory before abrupt upturn in energy demand and other serious matters including high level of losses because of corruption, bad governance and inefficiency. In this matter, restructuring of energy sector was initiated in the form of "Strategic Plan for Restructuring the Pakistan Power Sector [PPRSP] in 1992," which was endorsed by the Government of Pakistan (GOP)/ Council of Common Interest (CCI) and followed by Energy Policies of 1994 to 2002.

In 1997, “The Regulations of Generation, Transmission and Distribution of Electric Power Act” was presented. NEPRA was under this framework created as entirely autonomous regulatory authority. WAPDA’s power wing was exclusively restructured and transfigured into further four entities. These include GENCOs, DISCO’s, NTDC and KESC (Karachi Electric Supply Corporation). This distribution of responsibilities was taken within the frame of corporate law and was taken under the administration of PEPCO (Pakistan Electric Power Company). Later, KESC was privatized and renamed as K-electric. The memorandum and articles of association of PEPCO was signed in 1998.

As an outcome of this restructuring, two interconnected energy systems are placed in a country. First one is the Pakistan Electric Power Company (PEPCO) which is a public entity. It comprises number of governmental thermal energy generation companies including a transmission company (NTDC), the distribution companies (DISCOs) which is responsible for providing energy to entire country excluding Karachi. The K-Electric Limited, which is functioning in Karachi, the sole private vertically integrated energy utility in Pakistan and is responsible for generating or buying energy from IPPs falling in the area, and its further distribution. Second is the Central Power Purchasing Agency (CPPA) which functions as the only energy consumer for the PEPCO system while National Electric Power Regulatory Authority (NEPRA) regulates price, quality and entry into industry. Public generating units and private-owned Independent Power Plants generate energy which is collected into national grid operated by NTDC. NTDC further transmits the same generated energy to the ten DISCOs networks for onwards distribution to consumers.

**Malady of Pakistan’s Energy Mix:** As quantified in another place, hydel energy remained the backbone of Pakistan’s energy mix till 1990. However, from that point, the share of thermal-based energy production, comprising on natural gas, residual fuel oil, high-speed diesel and coal, grew disproportionately. Total installed production capacity was 28399MW in the end of FY 2017. Of the total installed capacity, thermal energy generation capacity stood at 18676MW, whereas, hydel remained immobile for the third consecutive year at 7116MW (including 214MW generated by private independent energy plants), nuclear at 1142MW, and renewable energy at 1465MW. From the thermal energy generation,

6785MW was generated from oil, 810MW from coal, and 8868MW from gas/RLNG. Several other energy plans are supposed to join the national grid by 2019 as about 9300 MW of CPEC projects comprising coal, hydro energy and renewable energy, while a supplementary generation capacity of 2880MW is under construction.

**Malady of Centralized Energy System:** there is no specific research which has been done on centralized system of energy governance as a factor of insufficient and inadequate energy supply. The centralized system of energy is very briefly discussed in the existing literature which also focusing from other angles on issues related to the system. However, it has not been portrayed as a contributory factor towards energy crisis, especially of supply side. However, most of these issues originated from centralized system. An extensive transmission and distribution network is required to supply energy to the consumers, as the energy generating units are positioned away from populated areas. On the contrary, essentially due to line losses during transmission and distribution, the costs for transmission and distribution which is almost 30% accounted for the cost of average delivered energy in centralized generation, whereas, it is unaccounted for energy and conversion losses (e.g., changing the voltage from high to medium and low). More specifically, this problem becomes critical in the case of electrification of low populated rural areas. During FY 2015-16 as it is one of the contributors of circular debt, transmission and distribution losses, remained at 18.7%. During the period of FY 2016-17 even the improved 17.9% losses against the authorized target of 15.27% at national level (excluding K-Electric) resulted in gap of over PKR 31 billion annually. Hence, even though installed capacity matches the demand, these increased tariffs and resultant non-payments of bills and theft contribute further to circular debt and suboptimal generation. Energy governance is found less attentive to solar technology utilization though Pakistan is potential country to avail solar energy.

In Pakistan, there is a great potential for hydel projects in the northern part of the country, its southern and south-western parts recorded greater irradiation levels which starts from South Punjab, which isthe highest annual global horizontal irradiance. For solar PV installations, there is a good resource measure which achieved in the Balochistan, as assessed

peak values exceed 2700 kWh/m per year in Western Balochistan, whereas, 83% area of the land still have potential of producing 2000 kWh/$m^2$per annum. Most of the values are found around the Sinai Peninsula which can be attractive for the investors from the Middle East and North Africa.

The decentralized generation with small run-of-river hydro energy projects, are executed in northern parts of Pakistan. For this reason, the massive potentials for solar-based decentralized generation stay unused. The government is investing prominently in establishing new generation units and in the transmission and distribution system but they are still comparatively less than generation which support evacuation of energy from these facilities. When the government electrify the outstanding 77% of the rural population, which is mostly distributed in small villages in interior South Punjab, Sindh and the sparsely populated Balochistan, the latter will be particularly costly. Unexpectedly, these same areas particularly South Punjab, are perfect for solar energy generation. Micro grids can be an effective and economically viable solution in the long run. It will take the load off the transmission and distribution system, not only to basic electrification of these remote and thinly populated areas, but also, with the supplementary large, supply generating projects in pipeline by decreasing the investment in its up gradation and maintenance. As a result, following central restraints need to be addressed.

**Malady of Legal Constraints:** NEPRA laws in Pakistan are currently only facilitating the private energy generation for the personal use, though private parties are not allowed to sell the generated energy. These feasibilities in NEPRA laws will encourage the self-financed energy generation for self-consumption. Similarly, at the provincial level, the provinces can generate their energy within their due capacities though they are not allowed to use this generation respective to the provincial needs. Hence, there is a need to review this legal framework to facilitate private enterprises and provinces to operate independent of the national grid.

**Malady of Technological Barriers:** As stated earlier, the current available cost-effective technologies offer low-voltage DC current for 8 hours only; the cost would rise

considerably for higher voltage and 24 hours operation, which would entail larger generation and storage facilities. A study to enumerate optimal size related to our villages' pattern essentials to be conducted while taking into account our sub-regional particularities.

**Malady of Circular Debt:** As there is a requirement to pay expenses related to generation, transmission, distribution and other related expenditures, the energy sector is in dire need of revenue. The financial ability of energy entities is under severe challenge because of the problem related to circular debt. The payments from different stakeholders including energy consumers, private producers, the national transmission agency, distribution companies, and the government departments are generally unpaid and remained due. Together with inadequate tariff, theft of electricity, corruption, losses, disagreements on tariff within FATA, AJK and KESC, role of federal and provincial institutions in delaying the payments, this disparity in generation cost and revenue gathered by PEPCO accumulates over time into huge sums owed to the generating companies. Due to losses suffered there is an increase in tariff as PEPCO is already incapable to meet its expenditures. In turn, further decrease in revenue take place as higher cost of energy promotes illegal use of electricity. Furthermore, these problems aggravate the issue due to insufficient tariff or dispute on tariff within various energy departments.

**Malady of Price Determination Mechanism:** Formerly, through an act of parliament in 1998, NEPRA was set up to regulate all the elements of energy sector. However, for the ratification of NEPRA tariff rates, an official notification was required from the government by the official channel. It again causes further delays and discretion. The government did not adjust consumer tariff, between the years 2003 and 2008. Tariffs were revised on regular basis subsequently afterward; however, those adjustments were dependent on the increased cost of supply while shortfall of the year 2003–08 remained unresolved. The government raised tariffs from less than PKR 5.50 per kWh in 2009 to PKR 9 per kWh by 2012. As there is great variance between tariffs decided by government and NEPRA, so in this regard the significant shortfall is that there was no unified tariff determination in Pakistan which necessities to oblige the international changes. Increased tariffs lead to energy theft which in turn imposing further hike in tariffs to bridge the gap

between revenue and losses which furthermore acquires more circular debt with bankrolled tariffs. This fashion a spiteful rotation entrained mainly due to mismanagement, inefficiency and unrealistic decisions by government.

**Malady of Fragile Security Situation:** In terms of improving energy development the prevailing security condition in Pakistan is not encouraging. Due to weak security infrastructure, the main areas of Pakistan with enormous energy reserves, for instance Balochistan and KPK, have failed to attract foreign investors at their fullest. From different grievances terrorism and restricted threats are originating which considered as main security issues related to energy security. Any possibility of investment in energy sector is rolled back, with such security uncertainties. The availability is also suffered gravely due to persistent bombing of gas supply lines and energy transmission systems in addition to the shrinkage in energy. The progress of exploration and production of petroleum and gas in hydrocarbon rich areas has badly hampered due to the undesirable security situation of country.

## B. Energy Specifics of China-Pakistan Economic Corridor

The energy decision and action in the 2015 was to generate energy with minimum cost. It focused on the use of coal in the power plants. Meanwhile, China was interested in exporting its excess power generation equipment and mobilizes its economic institutions to provide their assistance in coal-oriented projects. The government of Pakistan has taken various measures to circumvent the losses due to energy shortfall. Regardless of the efforts done by government in the past, the country is still starving for energy. The real challenge is to produce cheap and clean energy from sustainable means. The energy plants have been established under the umbrella of CPEC have huge investments involved. The concern is that these projects can impose environmental threats for the future. The expansion of the electricity done is mainly oriented towards use of coal in the power plants. The country has a choice to select the composition of fuel mix, however the decision are influenced under poor governance issue faced by Pakistan. This is also certain as the agreements between Pakistan and china indicate that these projects will add to the country’s sovereign debt burden. This

will have an effect on the circular debt of the country as well as liquidity crisis. The electricity has already become very expensive.

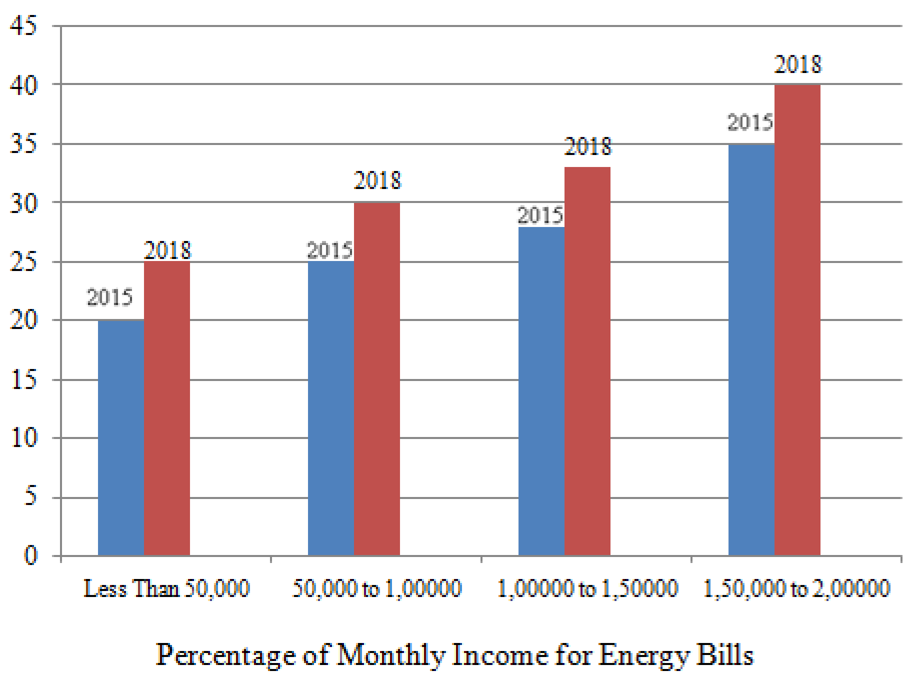
The economic prosperity of the country relies on the efficient supply of energy. CPEC is widely considered as an opportunity to phase out the darkness of the country. However, it is hardly understood by the masses that the solution lies in reform reversals. Poor implementation of the planning's derived in the past have resulted in form of poor performances. This is why issue of energy security is still lingering. It is implicitly important that the country does not solely depend on CPEC to resolve the situation. Indeed, the urging need of the time is to improve governance to achieve the objectives. It needs to be realized it is not merely about articulating these objectives, rather the way they are achieved matters. This needs pure intention with clear direction. CPEC might be a game changer for the future. So the country does not afford to squander this opportunity, just because of inefficiencies present within the governmental structure. The policies to be carried out in future should well thought out that considers a balanced fuel mix. The lifeline of the energy sector is dependent on institutional structure and their support. The administrative and political will matters in order to fully reap the benefits of the projects being carried out.

In 2005, the federal government endorsed the Pakistan Clean Air Programme. It identified vehicular emissions, industrial pollutants, natural dust and combustion of solid waste as the primary sources of air pollution in the country. The biggest problem with the issue of resolving air pollution is its perception within our society and treatment by officials. As mentioned before, air quality remains abysmal throughout the year but it is taken as a serious concern only during smog season in the fall and winter. The biggest problem with the issue of resolving air pollution is its perception within our society and treatment by officials. As mentioned before, air quality remains abysmal throughout the year but it is taken as a serious concern only during smog season in the fall and winter.

In 2018, Greenpeace carried out research to identify concentration of nitrogen dioxide (produced by the burning of substances like coal, diesel, oil and biomass. Lahore fell among the top 50 global hotspots. It is only plausible to claim that this concentration is likely to

increase with increased burning of coal in Pakistan with respect to the seven coal-fired plants planned under CPEC out of which two- Sahiwal and Port Qasim plants are currently operational. The following map shows the energy projects undertaken by CPEC. With an increasing energy demand, it became crucial for steps to be taken to provide electricity access to all citizens in the country. The way adopted by the government of PMLN (2013-2018) was to engage in CPEC with China. If they had played their cards right, it could have been a tremendous opportunity for Pakistanis to achieve the UN SDG of clean and affordable energy. According to research by Columbia University's Centre on Global Energy Policy, the government of that time wanted to take credit for the work it planned to do and therefore agreed to coal power plants for short-term power generation instead of investing long term in non-renewables. Conserving foreign exchange was another factor which apparently compelled Pakistan to take this decision. Consequently, almost 75% of the energy generated by CPEC projects is supposed to come from coal combustion. The study concludes that the energy prices have gone up in the period of 2015-2018, the survey conducted by the study in June 2019 gives the evidence (See Table 6.1).

**Table 6.1: Comparison of Percentage of Monthly Income for Energy Bill (2015-2018)**




**Source**: "Pakistan Economic Survey 2018-19", *Finance Division*, pp. 236-237

As mentioned before, most of Pakistan's greenhouse emissions come from energy sector and within that primarily from coal. The CPEC projects stand to increase Pakistan's reliance on coal by almost 50% in a time when global efforts are being taken to reduce coal reliance. Antonio Guetteres, Secretary General of the United Nations, while in Bangkok for an event commented that coal addiction "must be overcome" to overcome disastrous effects of climate change.

Coal-fired plants pose a threat because coal combustion contributes several pollutants and airborne toxins to the atmosphere thus worsening human health and the impacts of climate change. Greenhouse gases like carbon dioxide and methane are produced during the process of combustion and coal formation respectively. The following table shows the quantity of carbon dioxide that four out of seven CPEC coal projects are estimated to contribute to the atmosphere thus worsening the already poor air quality. In addition to pollutants from coal combustion, experts claim that coal-fired power plants have set the smog off in Pakistan. The focus for this section may have been air pollution but the same coal projects also contribute to increase in average temperature and disrupt the water cycle. In short, the environmental disasters brought by these coal projects far outweigh the perceived economic benefits.

# I. Findings

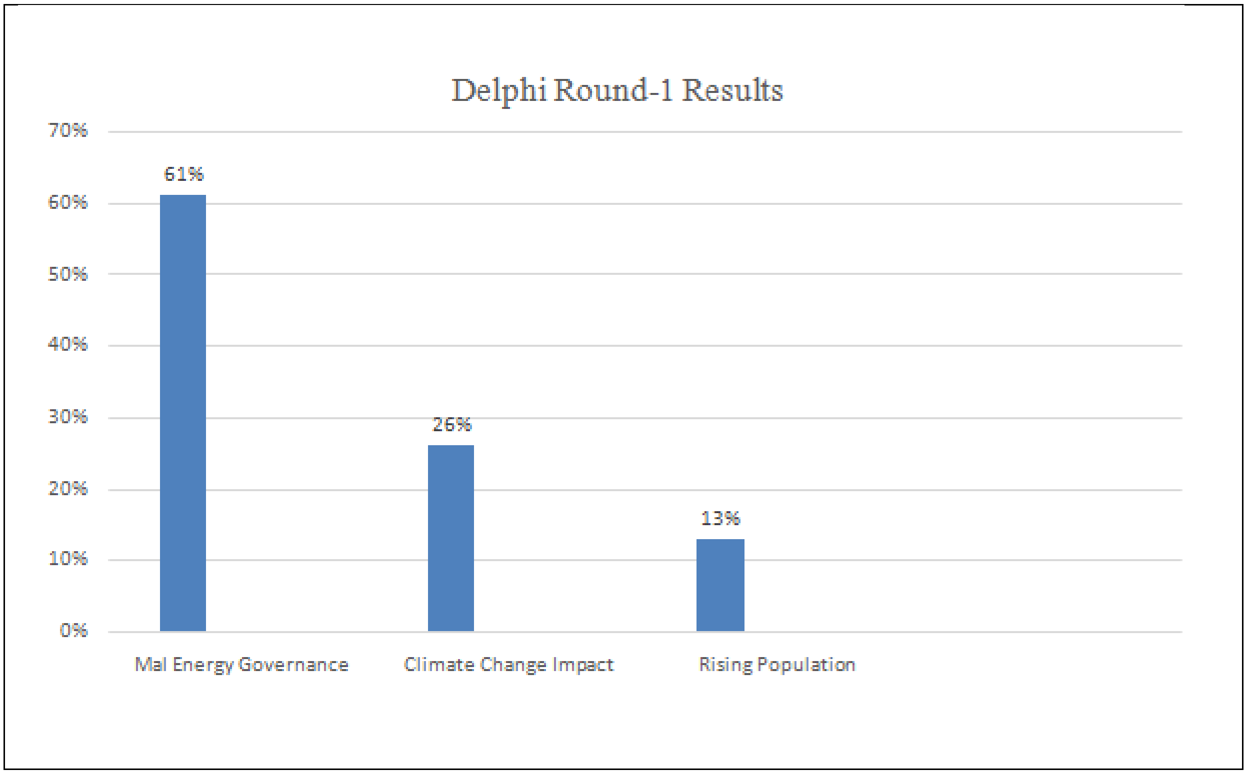
This section of the study enumerates the findings of research as follows.

## Delphi Result Round 1

Real premise of the study pondered: to enumerate the causative factors of energy crisis of Pakistan and explain their variance in comparison to each other. The purpose is to identify real determinants of the crisis of energy and its relationship to CPEC. The causative factors deliberated are: socio-economic development, climate change and challenges to energy governance. The significance of each variable causing energy crisis is discussed. The study relies on knowledge and opinion of experts obtained by utilizing Delphi focused method (See

Annexure I) to prioritize the variables of the study. Chapter 3 moved from generally understood reasons of energy crisis e-g socio-economic development, and climate change to specific reason of energy crisis e-g, mal energy governance discussed as prime factor causing energy crisis.

**Figure 6.1: Causative Factors of Energy Crisis of Pakistan**



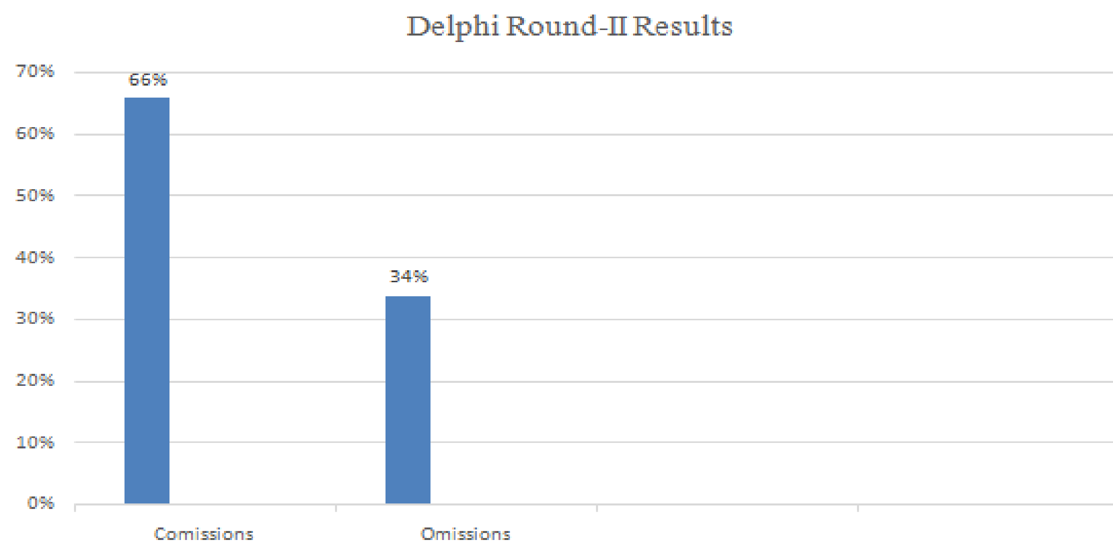

The priority is based on results of Delphi round 1 (See Figure 6.1). 61% experts determined the mal energy governance the first reason, 26% called climate change impact the first reason, while 13 recognized socio-economic development in sequence to rising population the first reason responsible for energy crisis of Pakistan.

## Delphi Result Round 2

**The study identified energy institutions composed of all decisions and actions of legislature, executive and judiciary bearing the capacity to affect the energy resources of the state.**

The energy institutions in Pakistan are set to achieve the objective of reducing uncertainty in the development of energy. Institutions are evolved through different constitutions, legal procedures, contracts between individuals, norms of the statue and common laws. They have defined structure of economy to increase feasibility and profitability during energy development. The energy governance of Pakistan has emerged from the combination of politico-economic behavior of politicians on treasury benches or in opposition of the government.

**Figure 6.2: Round II: How do you Prioritize the Reasons of Energy Crisis in Pakistan referred Energy Governance of Pakistan**




*Commissions: The committed energy decisions and actions; caused the energy crisis in Pakistan e-g, IPPs Project
*Omissions: The omitted energy decisions and actions; caused the energy crisis in Pakistan e-g, Kalabagh dam

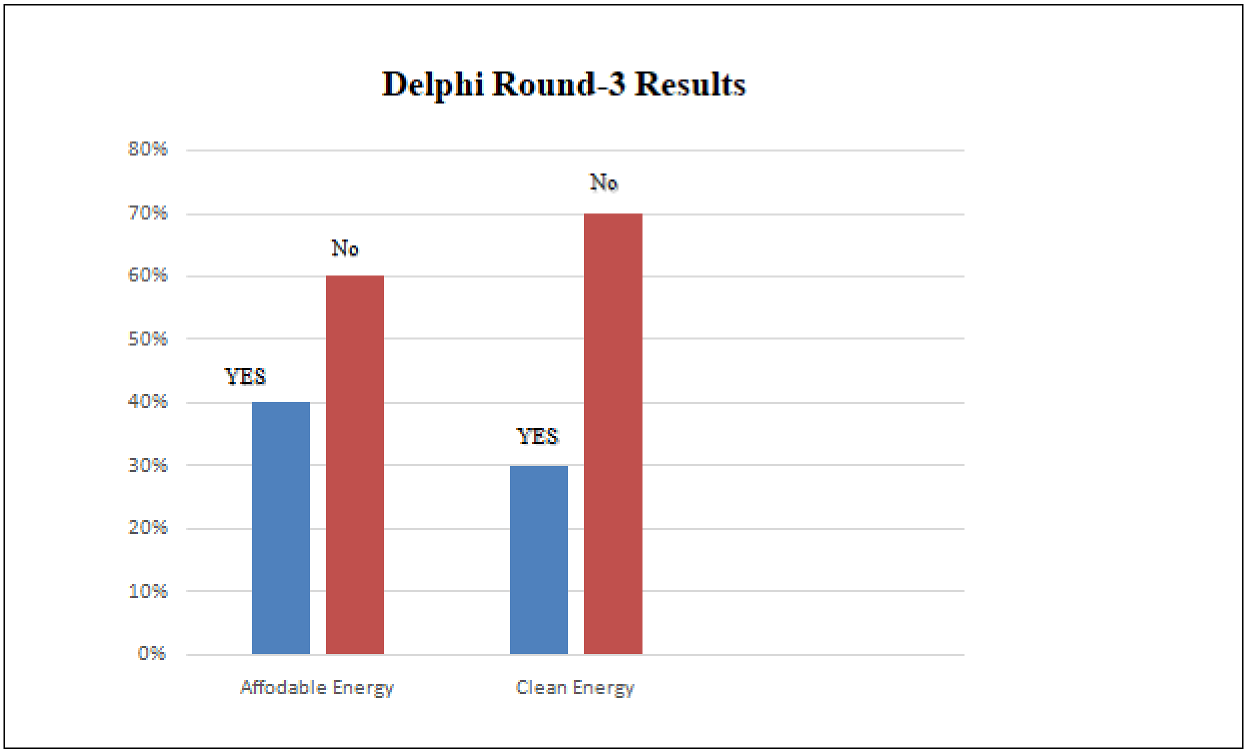
The source of divergent energy decisions and actions is the political and business affiliations of the individuals working in institutions. The energy institutions at national level spell their rules into provincial and community levels of governance. Institutions offer a reliable and structural way of communication with incremental changes. Better knowledge, factual data and variability of valuable attributes provides the way for maximum dependence on institutions for a structured and cost-effective energy development. Institutional change through the alternation in the formal rules of game is found the best way of increasing return features of an institutional framework. Political parties impose constraints on interaction to structural changes in the energy institutions.

The specialized interdependence occurs between the institutions because of specialized interest e-g, energy development. Institutional and technological interactions define transaction costs that are summed up to proclaim production cost. This study identifies the two dynamics of energy governance of Pakistan one is formal institutions and the other political parties and their manifestos as informal institutions. The institutional and technological interactions are defined in perspective of China Pakistan Economic Corridor (CPEC) signed in 2015. The Delphi round 2 results are presented on the basis of responded knowledge and expertise of 15 experts for this study (See Figure 6.2). The study found that the energy crisis has been evolved in Pakistan because of 66% commissions. Commissions: The committed energy decisions and actions; caused the energy crisis in Pakistan e-g, IPPs Project. 34% respondents reported that the energy crisis accumulated in Pakistan because of omissions. Omissions: The omitted energy decisions and actions; caused the energy crisis in Pakistan e-g, Kalabagh dam.

## Delphi Result Round 3

The CPEC 2015 energy decisions and actions in Pakistan are clear evidence of energy production dependency of Pakistan. Institutional and technological interactions define transaction costs that are summed up to proclaim production cost. Chapter 5 assessed the CPEC projects following the energy security index. The study highlighted the two dynamics of energy security endorsed by UNO one is affordable energy and the other is clean energy. The energy sustainability is explained in perspective of China Pakistan Economic Corridor (CPEC) signed in 2015.

**Figure 6.3: China-Pakistan Economic Corridor in Flash of Affordable and Clean Energy**




The Delphi round 3 results are presented on the basis of responded knowledge and expertise of 15 experts for this study (See Figure 5.1). The experts (60%) opined that the energy production secured through CPEC will not be affordable; while 70% experts asserted that the CPEC energy will not be environment friendly.

## III. Recommendations

Following are the recommendations of the study.

**Long Term Energy Plans:** Some positive signs are found to overcome the energy crisis of Pakistan. 2030 Vision of Pakistan emphasizes the energy security. In 2007 during the period of Prime Minister Shaukat Aziz Planning Commission of Pakistan formulized energy framework consulting many energy experts. For example, the Asian Development Bank (ADB) report, published in 2010, argued that with swift action Pakistan could be on the right energy trajectory within three years. Energy policies are just a tool to address the prevailing energy crisis. They come into effect only when the governments implement these policies

efficiently. The country has to suffer long term consequences if policies become a tool for the influential to guard their own interests instead. While implementing the policy there are many millstones in the way, sometimes they are so complex and interlinked that the struggle behind formulating the policy as an immediate response fails in spirit. While achieving one goal there is an opportunity of sacrificing the other in the way. For instance, while covering the energy crisis environmental concerns are widely ignored. There is a need to incorporate a sustainable policy rather than opting for rampant solutions.

To build a sustainable energy policy it is imperative that socio economic and environment are looked upon with an equal eye. There is a need that the country derives a policy which brings every party on the same page. It is notable that the shifting and switching between the resources used to generate energy shows lack of clear direction. Every party seems to have its own priority and choices regarding the fuel mix they want to use in the energy plants. In fact, the only basis of selection of the fuel should be in line with the new technology adopted around the world that is expected to generate sustainable results, such as renewable energy. The economy and environment have to face the losses that are incurred due to governance failures. There is lack of integration within the institutions. Moreover, corruption, lack of commitment gives a view that the leadership does not have a clear vision. The energy has become so expensive that it is beyond the reach of common man to afford it. This has also slowed down the industrial sector of the country. The charges to connect with the national grid are also very high. Thus, a large part of the country has to undergo from the darkness. The main reason for this price hike is the reliance on imported fuel instead of the natural resources the country is blessed with. The country needs to shift from the conventional means of producing energy. Incorporation of renewable energy sources in the fuel mix can play a vital role to reduce the energy deficiency of the country.

**Capacity Building of Energy Governance:** Management requires a lot of work in sustainable decision making. The developed nations like Malaysia, Korea, Chile, England and US have successfully managed all their issues related to their energy sector by enriching institutional capacity to view the experience and future challenges. Analysis of the energy institutions of developed states shows that effective institutional management from top to

bottom increases the possibility of success of energy development to maximum. The policymakers must be equipped with profound knowledge of energy, resources for energy production, energy production, energy policies and the impacts of the policies after their implementation. As the ultimate decisions come from policy makers so they must be given requisite exposure of the subject through training and seminars aimed at enhancing required knowledge of policies.

**Research on Energy Development:** Energy experts and researchers, with attractive incentives, must be appointed to do research on the production of energy through indigenous resources and to ensure its availability at low prices. The concerned authorities must deem well and peruse policy documents thoroughly and, if required, may collect expert opinions internationally before signing them.

**Coordination among Institutions for Affordable and Clean Energy:** Institutional policies must be reassigned to provide a foundation for the achievement of self-sufficiency in the energy sector of Pakistan. Through effective institutional governance, the element of corruption in energy institutions must be rooted out for it paralyzes the performance of overall sector. Effective energy reforms must be introduced to ensure effective management of energy resources and judicious integration of renewable energy technologies. Energy institutions must formulize long-term and efficient energy strategies to gain maximum benefit from the policies in general and CPEC energy in particular for an affordable, clean and sustainable energy.

**Vitalizing Energy Relations with China and Germany:** In the international energy system, China and Germany are known for energy development. Pakistan must organize its relations with China to get maximum benefits from CPEC and their experience in renewable energy to lower energy production cost. The energy system of Pakistan must be reorganized and sanely governed to manage it effectively in order to gain efficient results from CPEC for affordable and clean energy to ensure energy security. Easily available, accessible, affordable and paramount CPEC energy must be utilized for economic development and also to support the burgeoning population of the state. The dependence of Pakistan on fossil fuel-based

energy and especially imported furnace-oil must be cut short. This would help in the reduction of energy unit price and protection of environment as well. Viewing the utilization of renewable energy resources of China for energy production, Pakistan must utilize renewable energy resources for cheaper and environmental friendly production of energy. Fossil fuels are rapidly depleting and are extremely vulnerable to exogenous shocks and fluctuations. Global warming is resulting in premature melting of glaciers and thus water scarcity is making hydel projects improbable. In these times, the threshold opportunity of CPEC energy must be ingeniously utilized to save the economy of Pakistan from improbability and the shocks of price hike. Produced energy must be provided efficiently.

**Dependence on Foreign Investment Must be Reduced:** The incentives must be provided to the private sector in the energy policy making. The energy plans must be completed to reducing energy crisis. It is suggested that the use of renewable resources will reduce the reliance on imported fuel. The importance of using indigenous resources was stressed upon so because the country is already heavily indebted.

**Beyond the Election Cycles:** In order to overcome this menace, perception about air pollution in public and government circles needs to be changed. Major cities like New York and Shanghai were able to overcome poor air quality through a vision that was not limited by election cycles of the government or temporary benefits brought by unsustainable practices. It is crucial to let go of our coal addiction and resort to solar, wind, nuclear and hydro power permanently. No step taken by the government can succeed without a supply of money. It will be an overall constraint on the economy in the short-term but a fruitful investment in the long-term. Capital ought to be invested in clean, affordable and renewable energy projects instead of continuing to use redundant refineries and poor-quality fuel in the transport and energy sectors. There is no question on the fact that a government has the responsibility to provide clean air to its citizens, not rob it of its life (135,000 people every year to be exact) by signing agreements for coal projects.

The potential benefits that are expected can only be achieved if the conflicts of interest and vested interests are wisely handled.

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# Annexure 1

## Techno-Economic Evaluation of CPEC-Energy

**Round I: How do you prioritize the reasons of energy crisis in Pakistan?**

Prioritize:

1. Socio-economic development (National/Regional/International perspectives)
   - High energy consumption patterns in the society
   - High energy wastage patterns in the society
2. Global Climate change impact (National/Regional/International perspectives)
3. Energy Governance (National/Regional/International perspectives)

| Guiding Principles of unstructured interviews in follow up of above points: |
|---|
| 1. Energy Outages<br>2. High Energy Prices<br>3. Unemployment,<br>4. Trade Deficit<br>5. Circular Debt<br>6. Slow Economic Growth and<br>7. Current Account Deficit |

Round II: **How do you prioritize the reasons of energy 'Crisis' in Pakistan referred Energy Governance of Pakistan?**

Prioritize:

1. Commissions: The committed energy decisions and actions; caused the energy crisis in Pakistan e-g, IPPs Project
2. Omissions: The omitted energy decisions and actions; caused the energy crisis in Pakistan e-g, Kalabagh dam

| Guiding Principles of unstructured interviews in follow up of above points: |
|---|
| 1. Energy Outages<br>2. High Energy Prices<br>3. Unemployment,<br>4. Trade Deficit<br>5. Circular Debt<br>6. Slow Economic Growth and<br>7. Current Account Deficit |

Round III: **How much CPEC energy production will sustain in future?**

1. CPEC energy is affordable
2. CPEC energy is clean

| Guiding Principles of unstructured interviews in follow up of above points: |
|---|
| 1. Energy Outages<br>2. High Energy Prices<br>3. Unemployment,<br>4. Trade Deficit<br>5. Circular Debt<br>6. Slow Economic Growth and<br>7. Current Account Deficit |